54.

U. S. DEPARTMENT OF AGRICULTURE.

OFFICE OF EXPERIMENT STATIONS.

W. O. ATWATER, DIRECTOR.

MISCELLANEOUS BULLETIN No. 3.

PROCEEDINGS

OF THE

FOURTH ANNUAL CONVENTION

OF THE ASSOCIATION OF

American Agricultural Colleges and Experiment Stations

HELD AT

CHAMPAIGN, ILLINOIS,

NOVEMBER 11, 12, AND 13, 1890.

EDITED BY

A. W. HARRIS, for the Office of Experiment Stations,

AND

H. E. ALVORD, for the Executive Committee of the Association.

PUBLISHED BY AUTHORITY OF THE SECRETARY OF AGRICULTURE.

WASHINGTON:
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1891.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
May 25, 1891.

SIR: I have the honor to transmit herewith for publication Miscellaneous Bulletin No. 3 of this Office, containing the proceedings of the fourth annual convention of the Association of American Agricultural Colleges and Experiment Stations, held at Champaign, Illinois, November 11, 12, and 13, 1890, which have been edited by the assistant director of this Office in conjunction with the chairman of the executive committee of the Association.

Very respectfully,

W. O. ATWATER,
Director.

Hon. J. M. RUSK,
Secretary of Agriculture.

CONSTITUTION

OF THE

ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

NAME.

This Association shall be called The Association of American Agricultural Colleges and Experiment Stations.

OBJECT.

The object of this Association shall be the consideration and discussion of all questions pertaining to the successful progress and administration of the colleges and stations included in the Association.

MEMBERSHIP.

At any regularly called meeting of the Association each college established under the act of Congress approved July 2, 1862, and each experiment station established under State or Congressional authority, the United States Department of Agriculture and the Office of Experiment Stations of the United States Department of Agriculture shall be entitled to one delegate. The same delegate may represent both a college and an experiment station, and may take part in the proceedings of the sections proper to either or both, but no delegate shall cast more than one vote either in a section or in convention. Other institutions engaged in experimental work in the interest of agriculture may be admitted to representation in this Association by a majority vote at any regular meeting of the Association.

Any person engaged in agriculture, who shall attend the conventions of this Association, not as a delegate, may, by vote of the convention, be admitted to all the privileges of the floor, except the right to vote.

OFFICERS.

The officers of this Association shall be a president, five vice-presidents, and a secretary, who shall act as treasurer. They shall be chosen by ballot, and shall perform the duties which usually devolve upon such officers. They shall hold office from the close of the meeting at which they were elected and until their successors shall be elected.

The president, secretary, and five persons to be chosen by the Association shall constitute an executive committee, which shall elect its own chairman.

The executive committee shall determine the time and place of the meetings of the Association; shall issue its call for said meetings, stating the general purpose thereof, not less than 30 days before the date at which they shall be held; shall provide a well-prepared order of business and program of exercises for such meetings; and shall make seasonable issue of said programs.

It shall be the duty of each institution included in this Association to present at each regularly called meeting, a brief report of the work and progress of said institution, and such report shall be called for in the regular order of business.

The executive committee shall be charged with the general arrangement and conduct of the meetings called by it, at which meetings, before adjournment, a new executive committee shall be chosen.

SECTIONS.

The Association shall be organized into sections upon the several classes of special subjects, the consideration of which shall become desirable. Each institution represented in the Association shall be entitled to representation in each section by one delegate. Each section shall nominate to the convention a chairman, to hold office until the close of the next convention. Each chairman shall present at the first general session of the convention a report of progress in his subject during the preceding year, together with any other facts connected therewith which he may deem of interest. Such reports shall not exceed 15 minutes in length. The annual address of the president of the Association shall be given upon the evening of the same day. Provision shall be made in the program for meetings of each of the sections, either simultaneously or consecutively as the executive committee shall determine. At least two sections shall each year present in general sessions of the convention a portion of the subjects coming before them. The sections to thus report shall be designated by the executive committee, and general notice of the selection shall be given at least three months in advance. There shall be sections on agriculture, on botany, on chemistry, on college work, on entomology, and on horticulture, and the executive committee upon request of any five institutions represented in the Association, shall provide for the organization of new sections at any convention.

AMENDMENTS.

This constitution may be amended at any regularly called meeting by a vote of two thirds of the delegates present.

RULES OF ORDER.

(1) The executive committee shall be charged with the order of business, subject to special action of the convention, and this committee may report at any time.

(2) All business or topics proposed for discussion and all resolutions submitted for consideration of the convention shall be read and then referred, without debate, to the executive committee, to be assigned positions on the program.

(3) Speakers invited to open discussions shall be entitled to 20 minutes each.

(4) In general discussions the 10-minute rule shall be enforced.

(5) No speaker shall be recognized a second time on any one subject while any delegate who has not spoken thereon desires to do so.

(6) The hours of meeting and adjournment adopted with the general program shall be closely observed, unless changed by a two-thirds vote of delegates present.

(7) The presiding officer shall enforce the parliamentary rules usual in such assemblies and not inconsistent with the foregoing.

OFFICERS OF THE ASSOCIATION.

ELECTED AT WASHINGTON, D. C., NOVEMBER, 1889.

President.

J. H. SMART, of Indiana.

Vice-Presidents.

M. E. GATES, of New Jersey.
F. A. GULLEY, of Texas.
G. T. FAIRCHILD, of Kansas.
R. J. REDDING, of Georgia.
E. W. HILGARD, of California.

Secretary and Treasurer.

H. P. ARMSBY, of Pennsylvania.

Executive Committee.

The PRESIDENT, the SECRETARY,
H. E. ALVORD, of Maryland.
W. H. SCOTT, of Ohio.
S. D. LEE, of Mississippi.
M. A. SCOVELL, of Kentucky.
E. H. JENKINS, of Connecticut.

Chairmen of Permanent Committees.

Agriculture, F. A. GULLEY, of Texas.
Chemistry, C. W. DABNEY, jr., of Tennessee.
Botany, S. M. TRACY, of Mississippi.
Entomology, S. A. FORBES, of Illinois.
Horticulture, W. J. GREEN, of Ohio.

Chairman of Standing Committee on College Work.

G. W. ATHERTON, of Pennsylvania.

ELECTED AT CHAMPAIGN, ILLINOIS, NOVEMBER, 1890.

President.

H. H. GOODELL, of Massachusetts.

Vice-Presidents.

O. CLUTE, of Michigan.
J. W. SANBORN, of Utah.
A. Q. HOLLADAY, of North Carolina.
I. P. ROBERTS, of New York.
E. D. PORTER, of Missouri.

Secretary and Treasurer.

M. A. SCOVELL, of Kentucky.

Executive Committee.

The PRESIDENT, the SECRETARY,
H. E. ALVORD, of Maryland.
M. C. FERNALD, of Maine.
J. H. SMART, of Indiana.
J. A. MYERS, of West Virginia.
W. M. HAYS, of Minnesota.

Chairmen of Sections.

Agriculture, C. S. PLUMB, of Indiana.
College Work, G. W. ATHERTON, of Pennsylvania.
Botany, B. D. HALSTED, of New Jersey.
Entomology, A. J. COOK, of Michigan.
Chemistry, A. T. NEALE, of Delaware.
Horticulture, E. S. GOFF, of Wisconsin.

CALL FOR THE CONVENTION.

ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES
AND EXPERIMENT STATIONS,
OFFICE OF THE SECRETARY,
State College, Pennsylvania, August 9, 1890.

By authority of the executive committee, a delegate convention of this Association is hereby called to meet at Champaign, Illinois, at noon of Tuesday, November 11, 1890.

Attention is called to the following article of the constitution of the Association respecting membership:

At any regularly called meeting of the Association, each college established under the act of Congress approved July 2, 1862, and each experiment station established under State or Congressional authority, and the Department of Agriculture shall be entitled to one delegate, but no delegate shall cast more than one vote. Other institutions engaged in experimental work in the interest of agriculture may be admitted to representation in this Association by a majority vote at any regular meeting of the Association.

In accordance with the requirements of the amendment to the constitution adopted at the last convention of the Association, the permanent committees on chemistry and on horticulture and the standing committee on college work are hereby designated to present a portion of the subjects coming before them in the general sessions of the convention.

The executive committee is not yet able to announce the program of the meeting, but will do so at an early day.

Very respectfully,
For the executive committee,

HENRY E. ALVORD,
Chairman.

H. P. ARMSBY,
Secretary.

PROGRAMS.

GENERAL SESSIONS.

TUESDAY, NOVEMBER 11.

3 *p. m.*—The Convention will be called to order. Report of executive committee. Appointment of committee on credentials. Action on program and rules of order Report of treasurer. Reports of chairmen of permanent committees: (1) Committee on agriculture, F. A. Gulley, chairman. (2) Committee on botany, S. M. Tracy, chairman. (3) Committee on chemistry, C. W. Dabney, jr., chairman. (4) Committee on entomology, S. A. Forbes, chairman. (5) Committee on horticulture, W. J. Green, chairman. (6) Committee on college work, G. W. Atherton, chairman. Report of committee on credentials.

5:30 *p. m.*—Adjourn.

7:30 *p. m.*—Address on behalf of the University, Regent S. H. Peabody, LL. D. Address on behalf of the citizens. Response and opening address by the President of the Association, J. H. Smart, LL. D., President of Purdue University, Indiana. Meeting of permanent committees.

WEDNESDAY, NOVEMBER 12.

9 *a. m.*—General session: Introduction and reference of resolutions and new business. "College and station work at the World's Columbian Exposition," A. W. Harris, assistant director of the Office of Experiment Stations.

10 *a. m.*—Meetings of permanent committees. Joint meeting of permanent committees on agriculture and chemistry.

12 *m.*—Adjourn.

2 *p. m.*—General session: Topics from permanent committee on horticulture: (1) "What effect will such legislation as is proposed for the protection of originators have upon experiment stations?" E. S. Goff, Wisconsin. (2) "The work of experiment stations in the reform of vegetable nomenclature," L. H. Bailey, New York. (3) "Methods of work in variety testing," W. J. Green, Ohio.

4 *p. m.*—Miscellaneous business and reports.

5:30 *p. m.*—Adjourn.

7:30 *p. m.*—General session: Discussion: "Should this Association take any action in cases where formal charges of misuse of the United States appropriations are made against any college or station?"

8:30 *p. m.*—Meetings of permanent committees, at which chairmen for the next year will be elected.

THURSDAY, NOVEMBER 13.

9 *a. m.*—General session: 1. Topics from standing committee on college work; "Waste in college work," J. H. Smart, Indiana. "To what extent can manual labor be advantageously employed in industrial colleges?" A. Q. Holladay, North Carolina. 2. Topics from permanent committee on chemistry: "Chemical research at the stations," C. W. Dabney, jr., Tennessee. Digestion experiments: (1) "Recent work abroad," H. P. Armsby, Pennsylvania; (2) "Work in America," W. H. Jordan, Maine.

12 *m.*—Adjourn.

2 *p. m.*—General business session: Reports of permanent committees and action thereon; reports of other committees; election of officers; consideration of resolutions; miscellaneous business.

5:30 *p. m.*—Final adjournment.

This evening is left open for social intercourse or such use as the Association may decide to make of it.

During the evening a train of sleepers will be made up on the Illinois Central Railroad and opened to passengers at 9 o'clock. This train will leave Champaign at 2:20 a. m., and arrive at Chicago early Friday morning. It is provided for those who wish to visit the Fat Stock and Dairy Show.

Friday, November 14.

Permanent committees or subcommittees thereof may meet for consideration of special subjects not requiring reports to the general convention or any action on its part.

MEETINGS OF PERMANENT COMMITTEES OR SECTIONS.*

The following topics for discussion in the meetings of the permanent committees have been furnished by the chairmen of those committees:

PERMANENT COMMITTEE ON AGRICULTURE.

F. A. GULLEY, Arizona, Chairman.

A standard milk test .... G. E. Patrick, Iowa.
Is a digestion experiment fallacious? .... H. P. Armsby, Pennsylvania. W. H. Jordan, Maine.
(The above to be discussed in joint meeting of committees on agriculture and chemistry.)
Plat experiments—the ideal and faulty system .... W. C. Latta, Indiana.
Equalizing the irregularities of plats, caused by defective germination .... T. F. Hunt, Illinois.
Pot against field-plat experiments .... W. W. Cooke, Vermont. C. E. Thorne, Ohio.
Specific points bearing on feeding experiments .... W. A. Henry, Wisconsin. H. H. Wing, New York.
The physics of soil tillage .... J. W. Sanborn, Utah.
Station records .... G. E. Morrow, Illinois.
What does a Lysimeter teach? .... For open discussion.
Testing grasses .... S. M. Tracy, Mississippi. F. L. Scribner, Tennessee.
Coöperative field experiments .... C. L. Ingersoll, Colorado.
Testing varieties .... J. F. Hickman, Ohio.

PERMANENT COMMITTEE ON BOTANY.

S. M. TRACY, Mississippi, Chairman.

Opening remarks .... S. M. Tracy, Mississippi.
Arrangement and use of reference books and herbaria .... J. C. Arthur, Indiana.
Herbarium methods .... F. V. Coville, Washington, D. C.
Outlook for cultivation of forage plants in the arid regions .... George Vasey, Washington, D. C.
Seed testing .... Gerald McCarthy, North Carolina.
Notes upon entomogenous fungi .... Roland Thaxter, Connecticut.
Nomenclature of plant diseases .... B. T. Galloway, Washington, D. C.
Methods of work with plant diseases .... T. J. Burrill, Illinois.
New plant diseases .... L. H. Pammel, Iowa.
Copper salts for black rot; fungicide apparatus .... W. B. Alwood, Virginia.
Fungicides .... D. G. Fairchild, Washington, D. C.
Coöperation in bulletins .... W. J. Beal, Michigan.
What should go into the bulletins? .... B. D. Halsted, New Jersey.

* The name Permanent Committee, adopted at the Washington convention, was changed, by amendment to the constitution at the Champaign convention, to Section.

PERMANENT COMMITTEE ON CHEMISTRY.

C. W. DABNEY, jr., Tennessee, Chairman.

Artificial digestion...Paul Schweitzer, Missouri.
Coöperative field experiments with fertilizers ....W. O. Atwater, Washington, D. C.
Methods for the analysis of milk ....G. E. Patrick, Iowa.
(The above to be discussed in joint meeting of committees on agriculture and chemistry.)
A review of newly proposed apparatus, methods, etc....E. H. Jenkins, Connecticut.

PERMANENT COMMITTEE ON ENTOMOLOGY.

S. A. FORBES, Illinois, Chairman.

Practical notes upon the use of insecticides ....M. H. Beckwith, Delaware.
A new root rot disease of cotton.....................George F. Atkinson, Alabama.
Notes on the more important experiments and observations of the season at the Iowa Experiment Station..................C. P. Gillette, Iowa.
Methods, technical and economic, with the contagious diseases of insects..S. A. Forbes, Illinois.
On the life history of the white grubs, with descriptions of immature stages ....S. A. Forbes, Illinois.
On the life history of the corn plant-louse, with economic suggestions..S. A. Forbes, Illinois.
New notes on the life history of the Hessian fly ....John Marten, Illinois.

It is recommended that the organization, equipment, and methods of entomological experiment stations be made a leading subject of general discussion in this section, and delegates are particularly requested to come prepared to report upon their own stations in these respects, and to describe the additions and improvements which their experience has shown to be desirable.

PERMANENT COMMITTEE ON HORTICULTURE.

W. J. GEEEN, Ohio, Chairman.

Methods of note taking for fruits..
Methods of note taking for vegetables..
Should reports on varieties not disseminated be made public through the medium of station bulletins ?..
Is seed control in any form needed ? ....
What important results may be expected from crossing and hybridizing ?...........
What classes of plants are most promising for such work ?..........................
The uses of greenhouses in experimental work.......................................
Methods of conducting germination tests..

PROCEEDINGS.

AFTERNOON SESSION, TUESDAY, NOVEMBER 11, 1890.

The convention was called to order at 3:25 p. m., in the physical lecture hall of the University of Illinois, by President Smart.

The following is a list of delegates and visitors in attendance as finally reported by the committee on credentials:

Alabama:

W. L. BROUN, President of the Agricultural and Mechanical College of Alabama.

GEO. F. ATKINSON, Biologist of the Agricultural Experiment Station of the Agricultural and Mechanical College of Alabama.

Arkansas:

C. W. WOODWORTH, Entomologist of the Arkansas Agricultural Experiment Station.

Colorado:

C. L. INGERSOLL, President of the State Agricultural College of Colorado and Director of the Agricultural Experiment Station.

F. J. ANNIS, Treasurer of the Agricultural Experiment Station.

Connecticut:

E. H. JENKINS, Vice-Director of the Connecticut Agricultural Experiment Station.

R. THAXTER, Mycologist of the Connecticut Agricultural Experiment Station.

B. F. KOONS, Principal of the Storrs Agricultural School.

C. D. WOODS, Chemist of the Storrs School Agricultural Experiment Station.

Delaware:

A. N. RAUB, President of the Delaware College.

A. T. NEALE, Director of the Delaware College Agricultural Experiment Station.

M. H. BECKWITH, Horticulturist of the Delaware College Agricultural Experiment Station.

District of Columbia:

E. WILLITS, Assistant Secretary of Agriculture.

W. O. ATWATER, Director of the Office of Experiment Stations.

A. W. HARRIS, Assistant Director of the Office of Experiment Stations.

C. V. RILEY, Entomologist of the U. S. Department of Agriculture.

L. O. HOWARD, Assistant Entomologist of the U. S. Department of Agriculture.

D. G. FAIRCHILD, Assistant Vegetable Pathologist of the U. S. Department of Agriculture.

T. T. LYON, Special Agent of the U. S. Department of Agriculture.

Florida:

F. L. KERN, President of the Florida State Agricultural and Mechanical College.

Georgia:

R. J. REDDING, Director of the Georgia Experiment Station.

J. M. KIMBROUGH, Agriculturist of the Georgia Experiment Station.

Illinois:

S. H. PEABODY, Regent of the University of Illinois.

G. E. MORROW, Agriculturist of the Agricultural Experiment Station of the University of Illinois.

T. J. BURRILL, Botanist of the Agricultural Experiment Station of the University of Illinois.

E. H. FARRINGTON, Assistant Chemist of the Agricultural Experiment Station of the University of Illinois.

T. F. HUNT, Assistant Agriculturist of the Agricultural Experiment Station of the University of Illinois.

G. W. MCCLUER, Assistant Horticulturist of the Agricultural Experiment Station of the University of Illinois.

W. L. PILLSBURY, Secretary of the Agricultural Experiment Station of the University of Illinois.

Indiana:

J. H. SMART, President of Purdue University.

C. S. PLUMB, Vice-Director of the Agricultural Experiment Station of Indiana.

J. TROOP, Horticulturist of the Agricultural Experiment Station of Indiana.

F. M. WEBSTER, Entomologist of the Agricultural Experiment Station of Indiana.

D. LOTZ, Assistant Instructor in Chemistry in Purdue University.

J. C. ARTHUR, Botanist of the Agricultural Experiment Station of Indiana.

Iowa:

H. OSBORN, Professor of Zoölogy and Entomology in the Iowa State College of Agriculture and Mechanic Arts.

G. E. PATRICK, Chemist of the Iowa Agricultural Experiment Station.

C. P. GILLETTE, Entomologist of the Iowa Agricultural Experiment Station.

Kansas:

GEO. T. FAIRCHILD, President of the Kansas State Agricultural College and Chairman of the Council of the Kansas Agricultural Experiment Station.

G. H. FAILYER, Chemist of the Kansas Agricultural Experiment Station.

Kentucky:

J. SHACKLEFORD, Vice-President of the Agricultural and Mechanical College of Kentucky.

M. A. SCOVELL, Director of the Kentucky Agricultural Experiment Station.

H. GARMAN, Botanist of the Kentucky Agricultural Experiment Station.

Maine:

M. C. FERNALD, President of the Maine State College of Agriculture and the Mechanic Arts.

F. L. HARVEY, Entomologist of the Maine State College Agricultural Experiment Station.

Maryland:

H. E. ALVORD, President of Maryland Agricultural College and Director of the Maryland Agricultural Experiment Station.

H. J. PATTERSON, Chemist of the Maryland Agricultural Experiment Station.

Massachusetts:

H. H. GOODELL, President of Massachusetts Agricultural College and Director of the Hatch Experiment Station of the Massachusetts Agricultural College.

Michigan:

O. CLUTE, President of the Michigan Agricultural College and Director of the Experiment Station of the Michigan Agricultural College.

A. J. COOK, Entomologist of the Michigan Agricultural Experiment Station.

L. R. TAFT, Horticulturist of the Michigan Agricultural Experiment Station.

Minnesota:

CYRUS NORTHROP, President of the University of Minnesota.

N. W. MCLAIN, Director of the Agricultural Experiment Station of the University of Minnesota.

W. M. HAYS, Assistant in Agriculture in the University of Minnesota and in the Agricultural Experiment Station of the University of Minnesota.

Mississippi:

J. H. CONNELL, Professor of Agriculture in the Mississippi Agricultural and Mechanical College.

S. M. TRACY, Director of the Mississippi Agricultural Experiment Station.

E. R. LLOYD, Agriculturist of the Mississippi Agricultural Experiment Station.

J. H. BURRUS, President of the Alcorn Agricultural and Mechanical College.

Missouri:

E. D. PORTER, Professor of Agriculture in the University of the State of Missouri and Director of the Missouri Agricultural Experiment Station.

Nebraska:

J. S. KINGSLEY, Professor of Agriculture in the University of Nebraska.

C. H. MORRILL, Member of the Board of Regents of the University of Nebraska.

H. H. NICHOLSON, Director of the Agricultural Experiment Station of Nebraska.

L. BRUNER, Entomologist of the Agricultural Experiment Station of Nebraska.

E. W. HUNT, Associate Professor of Rhetoric and Oratory in the University of Nebraska.

New Hampshire:

C. H. PETTEE, Dean of the New Hampshire College of Agriculture and Mechanic Arts.

L. D. STEVENS, President of the Board of Trustees of the New Hampshire College of Agriculture and Mechanic Arts.

F. L. MORSE, Chemist of the New Hampshire Agricultural Experiment Station.

A. H. WOOD, Agriculturist of the New Hampshire Agricultural Experiment Station.

J. KIDDER, Member of the Board of Trustees of the New Hampshire College of Agriculture and Mechanic Arts.

W. BROWN, Member of the Board of Trustees of the New Hampshire College of Agriculture and Mechanic Arts.

S. B. WHITTLEMORE, Member of the Board of Trustees of the New Hampshire College of Agriculture and Mechanic Arts.

New Jersey:

J. NEILSON, Acting Director of the New Jersey Agricultural Experiment Stations.

B. D. HALSTED, Botanist and Horticulturist of the New Jersey Agricultural College Experiment Station.

J. B. SMITH, Entomologist of the New Jersey Agricultural College Experiment Station.

New Mexico:

H. HADLEY, President of the Agricultural College of New Mexico and Director of the Agricultural Experiment Station of New Mexico.

New York:

H. H. WING, Deputy Director of the Cornell University Agricultural Experiment Station.

North Carolina:

W. F. MASSEY, Professor of Agriculture in the North Carolina College of Agriculture and Mechanic Arts and Horticulturist in the North Carolina Agricultural Experiment Station.

North Dakota:

H. E. STOCKBRIDGE, President of the North Dakota Agricultural College and Director of the North Dakota Agricultural Experiment Station.

C. B. WALDRON, Horticulturist of the North Dakota Agricultural Experiment Station.

Ohio:

W. H. SCOTT, President of the Ohio State University.

H. A. WEBER, Professor of Agricultural Chemistry in the Ohio State University.

C. E. THORNE, Director of the Ohio Agricultural Experiment Station.

W. J. GREEN, Horticulturist of the Ohio Agricultural Experiment Station.

C. M. WEED, Entomologist of the Ohio Agricultural Experiment Station.

J. F. HICKMAN, Agriculturist of the Ohio Agricultural Experiment Station.

H. J. DETMERS, Veterinarian of the Ohio Agricultural Experiment Station.

Pennsylvania:

G. W. ATHERTON, President of the Pennsylvania State College.

H. P. ARMSBY, Director of the Pennsylvania State College Agricultural Experiment Station.

W. FREAR, Vice-Director and Chemist of the Pennsylvania State College Agricultural Experiment Station.

G. L. HOLTER, Assistant Chemist of the Pennsylvania State College Agricultural Experiment Station.

Rhode Island:

J. H. WASHBURN, Principal of the Rhode Island State Agricultural School.

C. O. FLAGG, Director of the Rhode Island State Agricultural Experiment Station.

South Dakota:

LUTHER FOSTER, Director of the South Dakota Agricultural Experiment Station.

J. M. ALDRICH, Assistant Entomologist of the South Dakota Agricultural Experiment Station.

Tennessee:

C. W. DABNEY, jr., President of the University of Tennessee and Director of the Tennessee Agricultural Experiment Station.

H. E. SUMMERS, Entomologist of the Tennessee Agricultural Experiment Station.

Texas:

G. W. CURTIS, Professor of Agriculture in the Agricultural and Mechanical College of Texas and Director of the Texas Agricultural Experiment Station.

Utah:

J. W. SANBORN, President of the Agricultural College of Utah and Director of the Agricultural Experiment Station of Utah.

Virginia:

W. D. SAUNDERS, Director of the Virginia Agricultural and Mechanical College Experiment Station.

W. B. ALWOOD, Vice-Director, Botanist, and Entomologist of the Virginia Agricultural and Mechanical College Experiment Station.

West Virginia:

E. M. TURNER, President of the West Virginia University.

J. A. MYERS, Director of the West Virginia Agricultural Experiment Station.

C. F. MILLSPAUGH, Botanist of the West Virginia Agricultural Experiment Station.

Wisconsin:

F. H. King, Professor of Agricultural Physics in the University of Wisconsin and Physicist of the Wisconsin Agricultural Experiment Station of the University of Wisconsin.

E. S. Goff, Horticulturist of the Agricultural Experiment Station of the University of Wisconsin.

F. W. Woll, Assistant Chemist of the Wisconsin Agricultural Experiment Station of the University of Wisconsin.

The report of the executive committee was submitted by Henry E. Alvord, chairman.

REPORT OF THE EXECUTIVE COMMITTEE.

Immediately after the adjournment of the convention of the Association at Washington in November, 1889, the executive committee met and organized by the choice of Henry E. Alvord of Maryland as chairman, and H. P. Armsby of Pennsylvania as secretary and treasurer.

The committee having performed its duty under the constitution up to the opening of the annual convention of 1890, and having made the usual preparations for this meeting, now respectfully presents the following report:

When the last convention adjourned it was thought that this would be a year of comparative inactivity on the part of our organization, although a few matters were proposed as desirable to accomplish, but the year has proved to be one of much activity and some important results. The Association has aided in accomplishing four things worthy of special mention, two for the stations particularly and two for the colleges:

(1) Through proper representations made to the Agricultural Committee of the House of Representatives the annual appropriation under the Hatch act has been so framed as to secure the quarterly payments being made in advance. This is a great relief to most stations, and with a little attention this method of payment can be made permanent.

(2) Negotiations at the Post-Office Department secured an entire revision of the regulations for the free mailing of station reports and bulletins. The new regulations are liberal, and it is to be hoped that the advantages they give will not be abused.

(3) The special committee, appointed by the Washington convention, upon the relations of the colleges with the War Department, completed its labors in February, and the results were shown by the promulgation of a general order and a circular from the War Department, dated February 12 and 13, 1890, and further explained by the report of the committee, published in a circular bearing date of May 22, 1890.

(4) The Association has materially contributed to the early enactment of the law for "the more complete endowment and support" of land grant colleges. The executive committee holds a most gratifying letter from Senator Morrill, expressing his appreciation of the valuable assistance rendered by this Association in promoting the passage of the act of Congress approved August 30, 1890.

The new Morrill act had such inherent merits that it would probably have become a law in the course of time if left to pursue the usual routine of unaided legislation. It is safe to assert, however, that this measure is now operative law, and the colleges generally are now in receipt of the new income because this Association exists and because of its action during the last six months. This fact is recognized by the venerable author of the college acts of 1862 and 1890, and it has been characteristically acknowledged by the distinguished speaker of the Fifty-First Congress.

This new legislation was neither asked nor suggested by this Association and but few of its representatives knew that the author proposed to introduce the measure. But when the bill had been introduced, and Senator Morrill, in response to an

inquiry, expressed a wish to have it well supported, the executive committee was called together at Washington in April, and then commenced the active operations with which all interested are more or less familiar and which have constituted the main work of the Association for the present year.

The executive committee has endeavored to keep the institutions specially concerned in this legislation informed of its progress and of the situation of affairs by the distribution of circular letters. Thirteen such circulars have been issued during the year. The one dated August 30, 1890, is here inserted as a summary record of the proceedings in Congress.

OFFICE OF THE EXECUTIVE COMMITTEE,
Agricultural College, Md., August 30, 1890.

"The new Morrill bill, for the more complete endowment and support of colleges for the benefit of agriculture and the mechanic arts, has now become a law.

"This bill was introduced by Senator Morrill on March 25, 1890; was rewritten and again introduced April 30, and referred as S. 3714; on May 17 it was favorably reported, with amendments, from the Committee on Education and Labor, accompanied by Senator Blair's report, No. 1028. After being discussed at length on three different days and considerably amended the bill passed the Senate June 23 by a practically unanimous vote. June 24 the bill was read in the House of Representatives and referred to the Committee on Education; from this committee it was favorably reported to the House, without amendment, on July 12, by Mr. McComas of Maryland, accompanied by a report, No. 2697. On the 19th of August, under a special order adopted by the House, the bill was considered and passed, without a roll call, by a vote of 135 to 39. One amendment, generally agreed upon and made known in advance, was adopted by the House, and in this the Senate concurred on the 20th instant. The act was approved by the President to-day, August 30, 1890.

"Arrangements have been made for obtaining several hundred copies of the act as printed by the Department of State, and a number will soon be mailed to every institution concerned.

"A certified copy of the act will be furnished at once by the Department of State to the Treasury Department. The officers of the latter will then examine the law and make rulings as to the first payments under it.

"Another circular from this committee may soon be expected, giving the rulings made and describing all papers which should be sent to Washington by governors and State treasurers or other persons, to facilitate payments under the law.

"It is advised that, until the next circular is received by those to whom this is sent, all correspondence with or applications to the Government officials at Washington should be suspended. Confusion, delays, and unfavorable complications, liable to result from disconnected and dissimilar efforts, may thus be avoided. This suggestion may well be made to your board of trustees, and perhaps to the governor of your State."

The substance of the bill introduced by Senator Morrill on the 30th of April became a law on the 30th of August. This is considered as pretty quick work for so important a measure. Yet it required two months more of constant watching and assisting in the removal of obstructions to get the law fairly into operation.

The executive committee, and especially its subcommittee appointed at the April meeting in Washington, have felt the responsibility resting upon them during the past six months, and have labored earnestly to favor the interests of every institution entitled to membership in this Association. Incident to the work which has been done, it became necessary for the committee to appeal for aid to our representatives and friends in every State. With few exceptions, the responses were prompt and gratifying. Gentlemen went to Washington from Maine and Florida, Kansas and Dakota, and from numerous States between these limits to help on the good work. One made journeys of 1,000 miles each five times during the season. Another visited Washington

eight times, occupying at least three days on each trip. Several practically surrendered their summer vacation and held themselves in readiness to respond to the call of the committee for work either at Washington or in their respective States. Among the most active and effective workers were some who were unable to leave their homes. Nearly every college represented in this convention can claim a fair share in the labors which have resulted so well. The strength of our organization and its power for usefulness, when needed, have been once more demonstrated. The part which this Association has performed in securing the new Morrill act is just cause for pride and congratulation, although we can as yet form but a faint conception of the far-reaching effects of this act of August 30, 1890, upon industrial education and development in America.

A year ago the Association was congratulated upon being out of debt and the probability of getting along for a year or two with very small contributions to its treasury, but the unexpected work of the year has involved large necessary expenditures. A special request for $25 from each State was sent to the colleges [only] in June, and although this has been generally paid, as well as the contribution voted at the Washington convention, our treasury is now almost empty, while several hundred dollars are due upon accounts which ought to be promptly paid. Acting for the Association, in its name and for the good of all, the executive committee could do no less than promise to defray the necessary traveling and hotel expenses of those gentlemen who responded to the call for time and labor spent in visiting Washington and making other journeys incident to the work. The committee now appeals to the Association to make good these promises, and provide the means for settling the individual expense accounts still unpaid. The committee also considered it proper to relieve the Department of Agriculture from a part of the cost of a stenographic report of the proceedings of this convention

The report of the treasurer will show in detail that the receipts for the year have been $1,619.03 and the disbursements $1,472.51, leaving a balance on hand of $146.52. It is estimated that the unsettled accounts amount to about $1,000. This convention should therefore provide, before its adjournment, for raising $1,200 to $1,500 for the general wants of the Association during the next year. The committee recommends that each college be called upon to contribute $25 and each experiment station $10, as early as possible in the year 1891. Strangely enough, some of the colleges and stations which have received like benefits with the rest from the existence and work of this Association, do not seem inclined to participate in its conventions or feel any obligation to share in its proper expenses. Thus far the Association in all its operations has assumed that every institution eligible to membership under its constitution should be treated as an equal partner, although a silent one. But in view of this continued and unexplained silence in some cases, it is thought that this convention should consider what action, if any, should be taken in regard to future conditions of membership.

The committee repeats its belief, expressed in the report to the Washington convention, that in many ways not yet developed in detail the simple machinery of this Association, aided by the U. S. Department of Agriculture through the Office of Experiment Stations, may be made of direct practical use and economical value to the colleges and experiment stations in this country.

For the reasons stated last year, it has been found impracticable to secure concessions by the railroads to delegates attending this convention. It is understood, however, that the American Association for the Advancement of Science and several other organizations will meet in Washington next August It has been proposed that an effort should be made to have the annual meetings of all the various organizations which are usually attended by those likely to be delegates in our Association, held in Washington the same month in 1891. It is believed that a longer time in attendance, even if it should be prolonged for two or three weeks, will be fully compensated by saving time and expense in journeys to different places in different

months. If this plan be adopted, arrangements can unquestionably be made which will secure very advantageous railroad rates and an attendance at our next convention beyond all precedence. It is recommended that this matter be considered at the present convention, and that some expression be given as a guide to the new executive committee.

The committee formally submits to the convention the program prepared for this meeting and asks its confirmation, subject to such modifications as may prove expedient. It is recommended that the rules of order which have governed the proceedings of the Association for two years be continued.

Very respectfully submitted, for the executive committee,

HENRY E. ALVORD,
Chairman.

On motion of Mr. Armsby the report was accepted as read, and on motion of Mr. Fairchild the program recommended was adopted, subject to modification. Mr. Sanborn moved the appointment of a committee of three to take into consideration other recommendations of the executive committee. The motion was adopted and the president appointed Messrs. Sanborn (chairman), Fairchild of Kansas, and Plumb.

The Secretary and Treasurer, Mr. Armsby of Pennsylvania, submitted his report, as follows:

REPORT OF TREASURER.

H. P. Armsby, Treasurer, in account with the Association of American Agricultural Colleges and Experiment Stations.

DR.

To amount received from former Treasurer	$189.03
To cash received on account of call for 1889	75.00
To cash received on account of call for 1890	680.00
To cash received on account of special call of executive committee	675.00
	1,619.03

CR.

By bills paid on order of chairman of executive committee, as per vouchers on file	1,472.51
By cash on hand	146.52
	1,619.03

Mr. Ingersoll moved the appointment of a committee to audit the Treasurer's accounts. The motion was carried, and the President appointed Messrs. Ingersoll, Redding, and Flagg.

The President then called upon the chairmen of the permanent committees for the reports provided for in the constitution.

In the absence of Mr. Gulley, chairman of the committee on agriculture, and of Mr. Tracy, chairman of the committee on botany, the reports of these committees were postponed, and Mr. C. W. Dabney, jr., chairman of the committee on chemistry, was called upon for his report. He spoke as follows:

REPORT OF THE PERMANENT COMMITTEE ON CHEMISTRY.

In accordance with the article of the constitution which requires the chairman of each permanent committee to present at the first general session of the convention a report of progress in his subject during the year, I have the honor to submit the following report for the committee on chemistry:

Although, in accordance with this provision, this report might have much larger scope and include everything connected with the recent progress in agricultural chemistry, it is thought best, as our stations are (a majority of them) comparatively new, that this report should confine itself to the present condition and work of the chemical divisions of the stations in the United States. Hatch experiment stations have been established in forty-five States, and with one or two exceptions, chemical work has been in progress in all of them for over eighteen months.

Although it would be much more agreeable to the present writer, and doubtless also to this honorable assemblage, to devote this report to a discussion of the more notable and important discoveries in agricultural chemistry recently made, it seems our duty at this particular time to devote our attention to the more difficult and perhaps less agreeable and flattering labor of reviewing, in as much detail as possible, the work actually accomplished by our American stations. As this report is limited to a few minutes, we will only be able to take a bird's-eye view of the field of work.

As a basis for this report, we have prepared from the annual reports and bulletins and the Experiment Station Record, a series of tables covering the chief points about the condition and work of the stations. The main object of our investigation has been to ascertain exactly what the facilities and prospects are for original research in agricultural chemistry. According to the act, these stations are "to promote scientific investigation and experiment respecting the principles and applications of agricultural science," and it is "the object and duty of said experiment stations to conduct original researches." The majority of the investigations named in the original Hatch act lie, for a part at least, in the domain of chemistry. Research was then the chief end and object in the establishment of these chemical laboratories.

It is almost too early yet to expect to see a great amount of profound research completed, discussed, and published, but it is not too early to investigate the condition of the stations as to men and outfit, and in their other relations which favor or hinder chemical research.

The first requirement for chemical research is the specially trained, skillful, and devoted chemist; the next requirement is a good working laboratory. Given these, we must see to it next that the chemist is not loaded down with distracting duties and has not his time and energy entirely consumed with routine work. In compiling a list of chemists, therefore, we have paid especial attention to their other positions and duties, and have endeavored to find out how much real opportunity they have had for doing systematic original work. I have omitted from the list all of the directors and other officials, who, though professional chemists, appeared to have their time entirely taken up with administrative work.

The operative chemists of the stations may be classified as follows, according to the positions they hold and the different functions they have undertaken to perform:

Of the forty-four *chief chemists* only eight are free from college or other station duties; three have one other station office, such as director or vice-director; one is station chemist and State chemist for the fertilizer control; three are directors, station chemists, and State chemists—all at the same time; fifteen hold a full position, such as the professorship of chemistry in the college, in addition; two are station chemists, professors of chemistry, and State chemists; nine are professors in two subjects in the college in addition to being station chemists; one is professor of chemistry, director, and chemist all at once; one is vice-director, chemist, and professor; and a

last poor fellow is chemist, professor of chemistry, botanist, and professor of botany, etc., and here, at four different positions, I quit counting. There are two special chemists on the station staffs who are also full professors of chemistry in their colleges.

Next come the men who are doing the practical work, the assistant chemists. There are forty-three of these, who give all of their time apparently to station work, at least they have no college or other station work charged to them. One station has five, one has four, four have three, and two have two assistant chemists, each for all their time. Eight assistant chemists are assistant professors in the colleges, and one poor unfortunate is assistant director, assistant professor of agriculture, assistant chemist, and assistant something else, all at once.

This completes the list of chemists connected with the stations—forty-four chief chemists, fifty-two assistant chemists, and two special chemists in the forty-five stations reported, a total of ninety-eight chemists, and an average of nearly two and one fifth for each station; but there are only fifty-four chiefs and assistants who give the stations all of their time.

We have no means of ascertaining the special qualifications and training of these men. They are well furnished with degrees and loaded down with honors and offices, which must, I fear, consume all of their energies. But we will not be hasty in judging of this; "by their fruits ye shall know them," and their fruits are here.

The station laboratories.—But before taking up their fruits, there is another thing necessary for research—a well-furnished laboratory. We have endeavored to ascertain from the annual reports or college catalogues the condition of the station laboratories, and especially their relation to the college chemical laboratories. We have tried in each case to learn whether the chemical division had a separate building, a separate laboratory in the station building or one of the college buildings, separate rooms in the college chemical building or only an indefinite tenure to a portion of it. The information is not complete, but such as it is it is very significant and interesting.

The Massachusetts State Station has a separate building devoted almost exclusively to the chemical work of the station, and another laboratory building for botany and biology. The Connecticut State Station has a separate building devoted almost entirely to its chemical laboratories. California, Delaware, Indiana, Iowa, Kentucky, Louisiana Sugar, Maine, Maryland, Minnesota, New Hampshire, New Jersey, New York State, Pennsylvania, Tennessee, Vermont, and West Virginia Stations, all have good, some very handsome, separate station buildings containing the chemical and other laboratories and offices. The elegant new laboratory building of the New Jersey State Station merits especial mention as a model of its kind. From these fine outfits there are all grades of laboratories down to a "small basement room in the college building," which is reported by a new Western station. Thirteen stations are accommodated in an indefinite manner, perhaps very well, in the college laboratory; five have ample, well-equipped separate apartments in the college building. North Carolina has an extensive, well-equipped laboratory in the state board of agriculture building. The Connecticut Storrs Station has its laboratory at the Wesleyan University, at Middletown. On the whole, we think the stations are quite well equipped with buildings for chemical work.

Chemical work of the stations.—We endeavored to state, in the fewest words possible, in the table upon which this report is based, the subjects of the published chemical work of the stations from January, 1889, up to July, 1890. It includes the work contained in the annual reports for 1889, and in the Experiment Station Record as far as issued. We did not attempt to give all of the titles of the bulletins or papers published, but merely, in the most general terms, the subjects which have engaged the attention of the station chemist during this time, as exhibited by his published work. This work has been classified under three heads:

In one column we placed the work which may be considered as purely routine or ephemeral, such as the work on artificial fertilizers, manufactured or mixed feeding stuffs and other manufactured articles used in agriculture.

The second column is headed "Contributions to agricultural-chemical data," and includes all analyses of natural products or products of uniform character, such as analyses of soils, natural fertilizers, plants and parts of plants, fodders and grasses, ashes of plants, etc., and anything that might be included in any of our tables of chemical composition.

In the third column we have placed everything which could in any just sense be considered as belonging to systematic research. This portion of the table is doubtless very imperfect, as it is impossible in many cases to judge whether a certain piece of work should go in one of these last two columns or in the other; but the classification has been made in a liberal spirit, and with an earnest purpose to ascertain the general condition of the work of the stations. While we may not do full justice to individual stations, we believe the results as presented in the tables are of use for the purpose here intended.

Fertilizer work.—As fertilizer analysis forms such a large portion of the routine work of many of the stations, we have paid special attention to this, and give it two separate columns.

A circular letter was sent out to the directors of each station, containing the following questions:

(1) Please send me a copy of your State laws controlling the sale of fertilizers. What connection, if any, has your station with this control of fertilizers?

(2) What proportion of the annual appropriotion from the Government is used, directly or indirectly, in the control of commercial fertilizers? What aid do you receive from the State or from any other source for this special work?

The answers to these questions were compiled under two corresponding heads.

The result of this investigation may be summarized, as follows:

Five stations, Connecticut, Kentucky, Maine, New York State, and Vermont, exercise the entire fertilizer control—inspecting the fertilizers, making the analyses and publishing them. They are all well paid for their trouble by analysis fees or license taxes collected of the dealers in fertilizers. Maine is an exception which receives no tax money or appropriation from the State for this purpose. Five other stations, Arkansas, Alabama, Louisiana State, North Carolina, and Pennsylvania, make the analyses upon which the control is based. They all receive adequate compensation for their work, it appears, so that no Hatch funds are used for this purpose. In fact the fertilizer controls seem to pay the State boards of agriculture or the stations, as the case may be, quite handsomely. This appears to be a tariff, not so much for "protection" of the farmers as for "revenue" for the boards of agriculture and the stations. In the States of North Carolina, South Carolina, Georgia, Alabama, and some others the fertilizer control has produced large funds, which have been used for many other purposes besides the necessary expenses of the control itself. In seven cases, Georgia, Indiana, Mississippi, Michigan, New Jersey, South Carolina, and West Virginia, the station chemist or director is the State chemist at the same time, though there is no other connection between the fertilizer control and the station. In most instances the stations publish the analyses for the control. Nine States have fertilizer controls entirely independent of the stations and disconnected from them. Delaware, Florida, Illinois, and Rhode Island have separate fertilizer chemists; Maryland, New Hampshire, and Ohio have the fertilizer analyses made by the college professor of chemistry; Massachusetts has a fertilizer control by its State Station; fifteen States, all Western or Southwestern, have no fertilizer control at all.

It does not appear from our investigation of this subject that the business of analyzing fertilizers interferes directly with the legitimate chemical work of the stations. Some of our very best stations—those doing the highest class of chemical work—have entire charge of the fertilizer control. We think they are less fortunate where the

station chemist holds the independent position of State chemist and the station has no control of the matter, and we consider those stations most fortunate that have nothing whatever to do with the fertilizer control. This inspection or analysis is no more the duty of a Hatch experiment station than the inspection of coal oils, or flour, or any other commercial product sold in the States and requiring State supervision; and the State has no more right to use a portion of the Hatch fund to make analyses for their State control than it would have to take these funds to pay for testing any of these other articles of trade. This is a point which appears to be zealously guarded by the management of the stations, with perhaps a single exception.

Classification of published work.—We now come to the most difficult and the most unsatisfactory part of our report. It has been difficult, in the first place, in a hasty reading of the reports and bulletins of the stations, to fairly state the subjects and justly weigh the results of the work published. When this was done, however, as best it could be, and the data were inserted in the tables described, we found that we had a very interesting summary of the situation as regards the chemical work of the stations. The summary there presented is incomplete, no doubt. It probably does not do individual stations full justice, and may give undue prominence to results published by others; but, taken as a whole, we believe that its general teachings are worth considering.

Let us first see how the stations stand in the columns headed, respectively, (1) "Purely or routine ephemeral work," (2) "Contributions to agricultural chemical data," and (3) "Research."

Nearly all of the stations have something, of course, in the column of routine work, and this is no discredit to them, provided there is enough in the other columns. A few of the new stations and some of the branch stations publish no chemical work at all, and we omit them altogether from our account. It is to the credit of the California, Connecticut Storrs, Delaware, Illinois, Missouri, and Wisconsin Stations that they publish nothing which is classed by us as purely routine. The routine work done by the other stations consists of analyses of fertilizers, fertilizing materials, agricultural chemicals, special manures, home-mixed manures, manufactured feeding stuffs and feeding mixtures, minerals, mineral and drinking waters, etc., many of these being made probably for the accommodation of friends. Twenty-three stations appear, we are sorry to say, to have bestowed a considerable amount of time and labor upon work of this sort, varying from a few week to several months in the year. While it is doubtless true that newly established stations must inevitably do a considerable amount of this sort of work as a means of interesting the people and attracting their attention, we must believe that many of them are being sadly imposed upon, and that a few are allowing their attention to be too much absorbed by this work. The older a station gets the less it should have to do in this way.

As might be supposed, the great bulk of the chemical work of the station falls in the second column headed, "Contributions to agricultural chemical data." Leaving the new stations and the branch stations out of consideration, again, all except four have something in this column, and if we omit the Massachusetts Hatch Station, which has its chemical work done by the State Station, there are only three which fail to put in an appearance in this column. It is interesting to note in a general way the kind of work that the stations are doing.

Soil investigations, upon a larger or smaller scale, have been carried on in Alabama, California, Indiana, Maryland, Nebraska, South Carolina, Tennessee, and Texas. Nearly all of the stations have been making analyses of feeding stuffs, fodders, grasses, and hay. Connecticut publishes "An attempt to establish a method of valuing feeding stuffs," and there has been considerable work of permanent value done in this line in many other States. A number of the stations have been making chemical studies of agricultural plants. The work of the Missouri Station on Indian corn is the most noteworthy under this head. Nine or ten stations have been making analyses of milk and dairy products and studying the methods of determining butter fat in milk. The Wisconsin Station has, as we all know, done the most notable

work under this head, and a number of other stations have made valuable contributions to our knowledge. California, Florida, Maryland, and Tennessee have been studying their marls, gypsums, and other natural fertilizers. Georgia publishes a series of analyses of ashes of woods, and Massachusetts, of the ashes of fruits and vegetables. Five stations have been investigating Indian corn as a fodder and silage plant. The Iowa, Missouri, New Jersey, and Kansas Stations have been working on sorghum.

Among the more interesting special topics which fall in this column may be mentioned, investigations on the cow-pea by the Alabama, Georgia, and Connecticut Storrs Stations; of cotton-seed hulls and meal as food for stock, by the Tennessee, Texas, and Arkansas stations; of sugar-beets by the California, Colorado, Indiana, Iowa, Michigan, and Nebraska Stations. The California and Colorado Stations have been studying irrigation waters; the same stations and the Texas Station have made analyses of alkali soils; the New Jersey, New York State, and Colorado Stations have done especially notable work on alfalfa. Colorado has made analyses of tobacco.

Eight or ten stations have made notable contributions by way of laboratory methods or apparatus. Perhaps the thing we are all going to like the best is Dr. Babcock's new method for the determination of fat in milk. The New York Cornell Station gives us apparatus for drying in hydrogen and for the extraction of fats, and publishes a paper on Cochran's method of determining fat in milk and the variations as to fat in milk. The Maryland, New York State, South Carolina, and Texas Stations publish papers on the determination of moisture in air-dried feeding stuffs. The Pennsylvania Station publishes work along the same line, and the Connecticut State Station publishes some investigations on the determination of fat in feeding stuffs and on determining phosphoric acid by the citrate method. The Colorado Station has studied Professor Sachse's method for the determination of starch in potatoes, etc. Many of these subjects belong to the "research" column and are so located in the tables. We have enumerated them here because they belong with these studies of methods and apparatus.

Out of the forty well-established stations there are eighteen which publish work that comes under the head of "research." Being aware that our work is not complete and wishing to avoid invidious comparisons, we will not enumerate here those who do or do not appear in this column, but will content ourselves with mentioning some illustrations of the kind of work which we would especially commend. The California Station has a unique field of work, and one which it promises to occupy admirably. Its investigations of the soils of the regions represented by its branch station, of alkali soils, waters of irrigation, etc., are excellent. The Connecticut Storrs Station publishes a valuable paper on atmospheric nitrogen as plant food; its studies of the effects of nitrogenous fertilizers upon the production of crops and of different fertilizers upon the chemical composition of corn are of more than transitory interest. The Illinois Station has made a chemical investigation of silage, and the Kansas Station has been studying the composition of corn at different stages of growth. The Maine Station publishes many valuable results of feeding experiments with different feeding stuffs—hay, fodders, and silage—for milk and for growth. The Massachusetts State Station also publishes results of feeding experiments with cows and pigs. The New Jersey Station has given us a complete study of alfalfa, its composition and digestibility; and the New York State Station covers a good deal of the same ground in an excellent manner. The Pennsylvania Station studied the digestibility of corn fodder and silage in an exhaustive fashion. The work of the Wisconsin Station on fibrin in milk, on the general constitution of milk, and the conditions effecting the separation of cream well deserve to be classed under "research." This station publishes also many interesting digestion experiments with corn silage and fodder corn. The study of the life history of corn at different stages of growth, which has been published by the Missouri Station, is a fine specimen of this kind of work.

This quite incomplete list of some of the better pieces of work done at the chemical laboratories of our stations should give us great encouragement. A careful review of the publications of the stations will doubtless discover many other investigations having the right object. When we consider that almost all of the old ash analyses of American crops need to be made over again, owing to the imperfection of the methods and apparatus used at the time, we are surprised that only a few of the stations are making these analyses.

Altogether, we are impressed with the immense amount of chemical work that is being done at our American experiment stations; but when we sift out the small amount of original investigation which this mass contains we must acknowledge some discouragement. The chief object of these stations is, as stated at the opening of this paper, "to promote scientific investigation and experiment respecting the principles and applications of agricultural science." The chemical laboratory is the chief place for making such investigations.

Our leading object in this paper having been to give honestly the situation with regard to chemical investigation at the stations, we shall endeavor as honestly to state our conclusions with regard to the whole matter.

(1) We believe that our boards of control or directors are, many of them, too anxious to obtain immediate favor with the public, and are, by trying to show the farmer how he can make his business pay a little better, pandering for popular support to a very base motive. This is a natural mistake for the newly established station to fall into. The desire to make the ordinary farmer feel our importance and to make a good show at first, is leading many to build their stations without any solid foundation whatever in good work. What good does all this analyzing of fertilizers, feeding stuffs, and fodders do the science of agriculture? They may help the farmer of to-day to save a few dollars, or to make a few more pounds of beef or butter, but until we know more about the function of the different fertilizing elements in a plant, and of the value to the animal of the various compounds in them, we shall make little or no real progress with our science. We must teach our farmers that a system of practical agriculture can only be established upon the facts of chemistry, botany, etc., as a foundation, and that underlying all of our wonderful recent progress in agricultural methods are the long and tedious investigations, like those of Liebig and Hellriegel, in pure science. If we are in poor favor in our States let us try the charm of good work and taking time to do thoroughly what we undertake to do, and the public will be certain to appreciate it.

(2) As a result, we fear that only a minority of the station chemists possess the motive and the training to enter upon original work. Many, we believe, need only to be shown their duty and how to perform it. They are zealous but inexperienced. This difficulty will be most rapidly removed by training new men in the colleges and universities to enter this field and by giving the men who are already in the stations a little more time in which to gain the practical experience they need.

(3) Many station chemists who have the motive and the training are overloaded with other work, and have, when these routine duties are done, no strength or time left for investigation. The remedy for this state of things is plain. Every station should certainly be able to afford one well-trained chemist who could devote his whole time to its work.

In conclusion, let me read from a letter which I take the liberty to use, although I have not consulted the gentleman to whom it was addressed, Professor Sachse, of Missouri:

MUCH ESTEEMED COLLEAGUE: Your letter, with description of the existing condition of the American experiment stations, has interested me much; it shows them to be in about the same position that the German stations are in, or at least were in, for the belief in experiment stations as institutions intended to furnish the questioning farmer in every case with a receipt for the relief of his troubles, had to be fought here also. This view, however, is certainly one of error, for to give practical receipts is probably easier in every line of human activity than in acriculture, with its

infinitely diverse conditions, and to follow blindly a given rule is almost certain to lead to disaster. I hold the opinion, therefore, that experiment stations should study the general conditions of the growth of plants and their relation to soil and atmosphere, including the conditions of the soil itself; and to strive to enable the farmer by instruction, somewhat like the lecture delivered before our own agricultural societies, to draw from general results the special conclusions applicable to his necessities.

You see I fully agree with your statement made in italics on page 28 of your ninth bulletin, viz: "that it is illusory for farmers to expect from any source such specific directions for the conduct of their business as to render the higher manifestations of intelligence on their part unnecessary." To be sure the benefits from really scientific work are not always plainly and immediately visible, but they are for that reason all the more certain and lasting; take, for example, R. Arendt's investigations on the growth of the oat plant, undertaken some 20 years ago, the value of which is perhaps only now recognized, when we refer certain phenomena in fertilization to the process of assimilation; or the works of Liebscher, in the *Journal für Landwirthschaft*, 35 Bd., 1887, page 335, who discusses these relations clearly, though not yet resting upon complete and satisfactory fundamental principles. So I might instance the work of Hellriegel and Wilfarth on the formation of root tubercles, with the splendid results following. And I should certainly not know where such important questions as to whether, when, and how fertilization by ammonia or nitrates can be solved to a better advantage than by the studying on the one hand the processes involved in the formation of albuminoids within the plant, and on the other, the relation of ammonia and nitric acid to soil, nitrification, etc.

I believe now, esteemed colleague, that your work has given quite handsome results in this very direction, and will certainly give more should circumstances permit you to continue it in the manner in which you began, and towards which I should be glad to have these lines contribute.

On motion of Mr. Atherton, it was ordered that the text of Mr. Dabney's report and reports from other permanent committees be incorporated in the proceedings, and that Mr. Dabney be requested to afford station directors opportunity to correct and complete the tables accompanying the report from the committee on chemistry, and that these tables then be published privately for distribution among colleges and stations only.

Mr. Forbes, chairman of the committee on entomology, was then called upon for his report. After stating that the report had been collected largely through circulars and letters addressed to agricultural colleges and experiment stations, that he had received replies from 43 stations, and had attempted to embrace in his report everything done since the last convention of the Association, he read as follows:

REPORT OF PROGRESS IN ECONOMIC ENTOMOLOGY.

Economic entomology is not a single, simple science, but its matter and its methods are drawn in part from each of several sciences. The really accomplished economic entomologist must be familiarly acquainted with the common insect species of his region, with their life histories and their relations to nature; he must have the training and facilities—the library, collections, and apparatus—and the ability to use these with expert skill, sufficient to enable him to learn rapidly and accurately whatever is known concerning any species having or likely to have economic relations, direct or indirect, immediate or remote; he must have the skill and mental methods of a practiced experimenter; he must be able to generalize correctly a mass

of heterogeneous data, to sift and weigh evidence, to form hypotheses and to verify them, to state tersely and clearly, and to reason closely. He must have a certain store of chemical knowledge to draw upon for insecticide experiments, of methodical ingenuity for the invention and construction of apparatus, and a very considerable knowledge of the agricultural and horticultural practice to enable him to suggest and test methods of field and farm management against the insect enemies of the farm and garden. He should be enough of a botanist to recognize or determine plants—both phenogamic and cryptogamic—and should have a familiar practical acquaintance with the methods of biological microscopy, without which the critical study of many important parts of his subject will be impossible to him. I need hardly say that he must be an excellent observer and a fair draftsman and that he must be enamored of his work.

It is not remarkable that with such a bill of particulars to satisfy even approximately, several of our experiment stations remain without entomological assistants, especially if we take into account the fact that most of them also require of their entomologists work in one or more other fields, perhaps not less difficult and extensive. Neither is it remarkable that the entomological work of the stations has made a quiet beginning, and that the main effort has been expended thus far on the simpler and less difficult subjects.

There are now forty-three States which have agricultural experiment stations established under the Hatch act, and entomological work is regularly provided for in thirty-one of these, leaving twelve with no such present provision. Only three of the former number, Arkansas, Iowa, and West Virginia, have assistants charged with no other duties than those of station entomologist, and in one of these, West Virginia, the entomologist is described as a "special agent." Two of the station workers serve also as assistants to the Division of Entomology in the U. S. Department of Agriculture, one is styled the zoölogist of his station, eight are entomologists and botanists, two are called biologists (their departments being essentially those of entomology and botany combined), and five add horticulture to their entomology. In two stations where no entomologist is employed, entomological questions are referred to the horticulturist or the agriculturist; in two the botanist is responsible for the indispensable entomology; and in one the horticulturist. Nineteen of the station entomologists also teach in their land grant colleges, thirteen of them entomology only, one entomology and agricultural chemistry, one entomology and zoölogy, one entomology and invertebrate zoölogy, two entomology, zoölogy, and physiology, four entomology and horticulture, one entomology and botany, one botany only, and one general natural history.

There have been published in the station bulletins and reports since our last meeting 813 pages of entomological matter, if we include under this head reports of field experiments with insecticides. During this period 8 new native enemies to agriculture have been reported by station workers. Two of them are wheat insects (a leather jacket or tipulid larva from Indiana and a frit fly from Kentucky), 2 infest beans in Kansas, 1 is a cranberry scale insect detected in New Jersey, 1 a new peach plant-louse from Virginia, 1 a box-elder gall-fly (a new species from Iowa), and a rhubarb borer (a snout beetle) in Ohio.

Besides these contributions from experiment station workers, I may mention a new homopterous insect, Delphax, found injurious to corn in Florida; two burrowing web worms infesting corn and grass in Illinois; a snout beetle (*Sphenophorus*) destroying corn planted on swamp sod in Illinois and Indiana; a new plum borer (*Euzophera*), a very injurious species—from Illinois, and a new cut-worm (*Agrotis morrisoniana*)—also extremely destructive—from the same State; a tulip-tree gall-fly in Massachusetts and the District of Columbia; a new enemy of the strawberry—a flea beetle—reported by Dr. Riley; a cranberry caterpillar from Wisconsin; and a caterpillar seriously injuring the rye by feeding on the heads, in Maryland, the last two also being first mentioned in the last Report of the U. S. Department of Agriculture.

In addition to these native species, new and old, which have been first reported during the year as enemies to agriculture, three injurious European insects have been published by station entomologists as new or recent arrivals upon our territory, whose presence has been made manifest here by damage to plants of economic value. Perhaps the most important of these is a wheat saw-fly, described in November, 1889, by Professor Comstock, in New York, and the same observer has discovered a hitherto unnoticed European hot-house scale insect. The gypsy moth, first reported in destructive numbers by Professor Fernald, of the Massachusetts Hatch Station, is another very injurious species from Europe, affecting a large variety of fruit and forest trees and flowering and garden plants. This, however, was first noticed in July of last year in a New England agricultural journal.

Here may also be mentioned three other newly imported insects not detected by station workers: a rose saw-fly, discovered in the Arnold Arboretum at Cambridge; the Mediterranean flour moth, a mill and granary insect of the first class, now approaching our territory by way of Canada; and a new spinach beetle, observed by Miss Murtfeldt, in Missouri.

At least equally important with these new or newly observed insect species are new contributions to the life histories of the better-known enemies of agriculture. A very elaborate and important study of this sort has been made by Harvey, of Maine, on the apple maggot. Others deserving of special mention are that by Comstock, on the wire-worms; by Smith, of the New Jersey College Station, on the horn fly; by Gillette, of Iowa, on the time of oviposition of the cut-worms; by Weed, of Ohio, on the life histories of many species of plant-lice and on the borers of herbaceous plants. Webster, of Indiana, has also done some important new work on the so-called bill bugs, species of the genus *Sphenophorus*; and Comstock is engaged in an elaborate investigation of the hop louse in New York. Investigations of the insect enemies of the yellow locust and of the spruce in West Virginia have been made by Mr. Hopkins, the special agent there.

Outside the stations, valuable observations have been made by Osborn, of Iowa, on the life history of the grass-root louse, and here in Illinois on the life histories and early stages of white grubs, wire-worms, corn bill bugs, corn plant-louse, Hessian fly, several cut-worms, and a considerable variety of gall gnats. How much this kind of work is needed for even the oldest and best-known insects of the farm is shown by the fact that our Illinois investigations of the past year have amended in very important particulars the current account of the life history of the white grubs and have added a new generation to the biography of the Hessian fly.

An account of the progress of experiment station work in entomology would be very incomplete without special mention of a class of papers which contain, it is true, little or no new matter, but which, nevertheless, present the results of considerable expert work in a form which makes them very useful to the practical farmer and horticulturist, and to economic entomologists as well. These are general systematic summaries—monographs, we might almost call them—of existing knowledge of the insect enemies of certain crops or of previously published literature on specific economic subjects. A special bulletin on "Cranberry insects," published by the New Jersey Stations; one on "Insects affecting forest plantations in the West," from the Nebraska Station; articles on "Insects attacking willows and poplars" and on "The caterpillars of the oak," by Lugger, of Minnesota; and one on "Insects injurious to the American elm," by Perkins, of Vermont, are important examples of this class of contributions. Bruner, of Nebraska, reports that he is now engaged on a similar monographic treatise on the insects of the sugar-beet, and Riley has in hand some exhaustive reports on the insect enemies of live stock and on those of grain and grasses. A summary of observations, new and old, on the corn bill bugs, published in the last report of the Illinois office; an elaborate bibliography of the literature of the chinch-bug (in the same); and the bibliographical volume issued from the office of the United States Entomologist, on his own writings and those of Mr. Walsh, are the principal contributions of this class made outside the field of station work.

To this record of strictly entomological investigation we have to add a greater volume of new results of economic experiments. These are all, so far as I have seen, to be included under the head of experiments with insecticide measures and materials, either chemical or biological. I shall have something to say presently concerning the narrow range of this experimental work, but confine myself at present to a report of the facts.

A good deal of attention has been given this year, as last, to field experiments with arsenical poisons for the codling moth and the curculio. Additional codling-moth work with these poisons has been done at the stations in Iowa, Delaware, and Oregon, the most important contribution of the year on this subject being Gillette's Bulletin 10, of August, 1890. Insecticide experiments on the plum curculio are reported from Iowa, Ohio, Indiana, and Minnesota, Gillette of Iowa having included the plum gouger also in his work. While the efficacy of the arsenical poisons for the codling moth is now sufficiently established and the best methods and conditions of their application are fairly well made out, the case of the curculio is less clear and will require additional investigation, especially on the peach.

A very important study of the effects of the arsenical poisons on the foliage of plants, greatly helped forward last year by the careful experiments of Gillette and Popenoe, has been further advanced this season by Gillette, Weed, Woodworth of Arkansas, and Professor Bailey, horticulturist of Cornell University Agricultural Experiment Station of New York. Gillette's discovery, that the caustic effect of the arsenites on foliage is considerably diminished if these are mixed with lime, is especially worthy of mention. [In this connection a new spraying apparatus, proposed by Thaxter, of Connecticut, may be mentioned. It is intended for the distribution of a poison spray from a small tank carried upon the back.] Atkinson, of Alabama, has collected and collated a considerable amount of evidence highly favorable to the application of London purple or Paris green in the dry instead of the wet state, for the cotton worm.

Other experimental insecticide work has been done in Ohio and New York for the striped cucumber beetle; on granary insects in Oregon; on the asparagus beetle and the imported elm-leaf beetle in New Jersey; on the cabbage-worm in Delaware; and on the woolly aphis of the apple in Oregon, where kerosene emulsion and lye were successfully applied to the root form, and a combination of whale-oil soap, resin wash, and carbolic acid to that on the branches. Underground insecticides have been treated by Smith in New Jersey and Webster in Indiana; Alwood, of Virginia, has used whale-oil soap with success on plant-lice of the egg-plant, and kerosene emulsion on his new peach aphis; and kerosene emulsion, tobacco water, and carbolic soap have been used to kill apple lice in Nevada. The station entomologist in the latter State has also found a tobacco decoction effective for the pear slug, but has failed with the arsenical poisons and hellebore for a rose caterpillar. Gillette has used a spray of the kerosene emulsion to free hogs from lice. Smith's experiments with the rose-bug in New Jersey only served to show that that hardy veteran is proof against pyrethrum, tobacco, London purple, naphthaline, carbolated and hydrated lime, digitaline, quassia, copper compounds, iron solutions, and kerosene emulsion. Corrosive sublimate killed the beetles and also the plants, and only sludge-oil soap promised usefulness.

A very notable advance in the use of insecticides for scale insects has been reported during the year by Mr. Coquillett, of California, an assistant of the Division of Entomology of the U. S. Department of Agriculture. It consists in a direct method for the evolution of hydrocyanic acid gas from cyanide of potassium by the addition of sulphuric acid and a little water. By this improvement the cost of materials has been reduced to about 26 cents per tree, and that of application has likewise been greatly diminished. Coquillett has also advanced materially our knowledge of the value of resin washes for the scale insects, his experiments giving the preference to a solution of 18 pounds of resin, 5 of caustic soda, and 2½ pints of fish oil to 100 gallons of water.

Experiments with insecticides and fungicides combined, first undertaken here by Weed and Garman, have been continued by the former gentleman the present year; Maynard, of Massachusetts, has also tried Paris green and sulphate of copper together for the potato beetle and the potato rot; and Washburn, of Oregon, has combined sulphide of soda, whale-oil soap, and Paris green for the codling moth and the apple scab.

What I have called experimentation with biological insecticides has been limited to work with the vegetable and animal parasites of insects. Under the former head Webster has reported to the Division of Entomology of the U. S. Department of Agriculture some partially successful attempts at the transfer of the *Entomophthora* of the chinch bug to previously uninfected fields in Indiana; under the latter progress has been limited, so far as I am aware, to a continuation of the already famous and epoch-making work of the Division of Entomology in the importation and multiplication of the parasites of imported scale insects. Work has been begun likewise by this Division upon the multiplication of the insect parasites of the codling moth, and upon the transfer of the bacterial diseases of the cabbage-worm to the boll-worm of cotton.

After presenting as much of this entomological work as may be thus roughly classified, I have left upon my hands a miscellaneous débris of minor observations and experiments upon a variety of injurious species. Comstock, for example, has successfully poisoned the imago of the wire-worm in New York; Webster has discovered a fungous parasite (*Entomophthora*) of an injurious tipulid larva; Gillette has studied the parasites and diseases of the cut-worms and of the cabbage-worm, and has given particular attention to the potato-stalk weevil in Iowa; Wickson has continued his experiments in California on the effect of *Phylloxera* upon various kinds of vine roots; Smith has made special studies of injurious plant-lice in New Jersey, has continued his experimental work upon the root chafer, and has made some observations on the grain aphis. The last insect has also been closely studied by Webster in Indiana, and the screw worm has received special attention in Texas and Louisiana.

Among the contributions of the assistants of the Entomological Division of the U. S. Department of Agriculture the work of Osborn on grass leaf hoppers is particularly notable and valuable. He reaches the conclusion that the loss due to the grass insects generally is equal to the amount consumed by stock in ordinary pasturage.

I shall do no real violence to my subject by making mention also of the most admirable work of Atkinson in Alabama, upon the eel worms affecting the roots of various cultivated plants, a work he is still continuing; and of the observations of Halsted on the occurrence of these highly destructive pests in the oat field. The same observer has reported injury to violets by these worms, and they have been found affecting heliotrope and other plants in hot-houses in Champaign, as well as radishes and other garden vegetables. Comstock, who has been engaged on one of these eel worms for the last two years, reports his work substantially finished.

To this too rapid summary of progress during the year I will add only two or three comments of a general nature.

Although the work of the station entomologists has been thus far carried forward without any scheme of coöperation or any subdivision of the field among the different workers, I do not see that either undertakings or results show any waste of labor or disadvantageous duplication of effort. Even all the numerous insecticide experiments seem worth while, and the work of each has at least served to verify, correct, or complete that of the others. The time will doubtless come when a better organization will be profitable, but at present I am of the opinion that the advantage is clearly on the side of individual, initiative, and untrammeled adaptation to the conditions of one's own work. Great benefit would result, however, both to the work and to the workers themselves from the early selection by each station entomologist of a special field of technical entomology, in which he might hope soon

to become an authority, whose determinations should be accepted by his fellow-workers, they, in turn, to reciprocate by passing upon his own special problems.

In scanning the experimental work of the past year I have been impressed by what I will venture to call its one-sided character. It will be noticed that this insecticide work is practically all experiments with poisons and with parasites, and that it is very nearly all horticultural. Nothing has been done even looking towards the use of apparatus for the mechanical destruction of insects. Very little has been attempted in an experimental way for the benefit of the farm as distinguished from the orchard and the garden. And, most serious omission of all, little or nothing has been done to improve what seems to me the great opportunity of the station entomologist—the opportunity to experiment with methods of farm management; with variations in the selection, distribution, and cultivation of crops; in the times of their planting; in the preparation and management of the soil; and, generally, in the resources of a skilled and intelligent agricultural method. Almost anyone so disposed may experiment with an insecticide, little being required by way of special preparation or facilities, but scarcely anyone not having land at his disposal from which no financially profitable crop is expected can experiment with variations in farm management as affecting insects injurious to the great farm crops; and even with this advantage, no one can work successfully who can not at least draw upon some store of agricultural skill, knowledge, and experience. In short, I would advise that from this time forward the entomologist and the agriculturist ally themselves for a joint attack on the great farm pests by a carefully studied adjustment of agricultural methods to the habits and life histories of the most destructive insects. I believe that the agricultural assistant or the skilled farm manager is quite as likely to be a useful ally of the economic entomologist as is the druggist's clerk.

Mr. Green, of Ohio, chairman of the committee on horticulture, next reported for that committee as follows:

The committee on horticulture organized by appointing three subcommittees, viz, on the revision of names of vegetables, on publication, and on revision of list of originators. The work undertaken in all these lines is still incomplete, hence nothing more than rate of progress can be reported.

The committee on revision of names of vegetables has formulated certain rules to be used in the naming of vegetables, which rules will be read and explained by Professor Goff.

About two thousand names of varieties of vegetables have been revised in conformity with these rules, but much remains to be done before the work is completed. The object of the work is to aid in bringing about a reform in vegetable nomenclature; also, to prevent the improper naming of new varieties. If the various stations coöperate in this, considerable influence can be brought to bear in both directions, particularly in preventing use of improper names in the future.

The committee on publication had in charge the work of collecting reports from different stations on new varieties of vegetables and fruits. Inasmuch as many varieties are sent to different stations for trial before dissemination, it has been thought best to collect and publish reports of the varieties in a special bulletin. The committee has not been successful in collecting a sufficient number of such reports to warrant the publication of a bulletin, but it is still too early in the history of many of the stations to expect much completed work of this kind.

When the horticultural committee was first organized the work of compiling a list of originators of varieties of fruits and vegetables was commenced. This list was completed and published, but the need of revision was soon apparent. This revision is now in progress and will soon be completed.

A résumé of the horticultural work in progress at the various stations need not be here dwelt upon, since the ground has been fully covered in a publication prepared last year by the committee.

Mr. Atherton then presented the report of the standing committee on college work as follows:

Mr. Chairman, your committee has no report to make, but the convention, of course, is entitled to a word of explanation. There are two lines that might have been followed in such a report: First, we might have made a statement of some quite important changes in the organization of the land grant colleges since our last meeting. In North Carolina, for instance, the land grant fund has been taken from the university, which had it for several years, and transferred to a new institution. In South Carolina the same thing has been done, the change taking effect on the first of the present month. In two or three other States similar changes have been made, but I supposed all our people understood them fully, and therefore did not think it worth while to take up time to make a full report on these matters.

Second, we might have referred to a matter which has occupied the attention of the committee, one about which we would have made a very full report, but from the fact that the subject is the principal topic in the report of the executive committee. I refer to the passage of the new Morrill act.

The President called for presentation of miscellaneous business.

Mr. Jenkins brought before the Association correspondence with Mr. Warington and Sir John Bennet Lawes, of England, with reference to a visit to this country to be made by Mr. Warington, with the object of delivering lectures upon the experiments carried on at Rothamsted, England. He spoke in substance as follows:

Sir John Bennet Lawes has made provision for the permanent establishment of a scientific experiment station at Rothamsted. By one condition of his gift it is required that once in three years some one from the station shall deliver in this country a lecture or a course of lectures on the results of the work of the station. Mr. Warington has been selected to deliver in 1891 a course of lectures, not exceeding six in number, on the nitrates in the soil, presenting the results of his observations and experiments. Some time ago I received from him the following letter:

You are doubtless aware that the Lawes Agricultural Trust has been constituted. One provision of the trust is that once in three years a lecturer shall be sent to the United States to lecture upon the Rothamsted experiments. The committee of management have asked me to go next year as the first lecturer.

The scheme being yet untried, it is important that we should be advised by the people in America as to what is best to be done. I now write to ask your advice upon the subject.

If I come I should propose, after an introductory lecture describing the Rothamsted experiments generally, to give an account of my own work while at Rothamsted on nitrification, denitrification, the nitrates in soils, drainage waters, etc. I may also add a lecture on the wheat crop. The lectures would not be less than six nor more than nine.

The first question that has to be answered I think is, What kind of audience is to be addressed? The audience might be (*a*) a general one, (*b*) farmers, (*c*) students at agricultural colleges. The introductory lecture might be easily made a popular one. Possibly one or two of the other lectures might have sufficient general interest to be worth giving to an unscientific audience; but I feel that I can not do justice to most of the subjects I wish to treat of unless I lecture to those who have some elementary acquaintance with science, and who have an interest in the questions which I discuss. As you are well acquainted with the topics I propose to bring forward,

you will be able to advise me on the subject. It seems to me at present that the agricultural colleges will be the most suitable places for these lectures.

If the agricultural colleges are fixed upon the questions at once arise: Which colleges? If you advise lectures to college students, please tell me which are your principal colleges. Where would we find most agricultural students? Which are the most important centers? During what months of the year could lectures be conveniently given in such colleges? Please do not confine yourself to a reply to the definite questions asked, but let me know your opinion as to the best way of carrying out the provisions of the trust.

One point I may name. I am not authorized to go to any expense attending the delivery of these lectures; expense of room, lighting, attendance, and advertising, if any, must be borne by those who attend the lectures.

HARPENDEN, HERTS, 9, 22, 1890.

I wrote him, explaining that I did so entirely on my own responsibility, not having had time to confer with others, substantially to this effect:

The one audience, it seems to me, that can least afford to lose your lectures is the one that gathers at the annual meeting of the Association of Agricultural Colleges and Experiment Stations. Each college and experiment station in the country is expected to send one or more delegates to this meeting, usually the president or director, and where the distance is not too great, part of the working force also.

The session continues through four days, and if it were announced that you were to be present and give this course of lectures I have no doubt that the delegates would arrange to remain and hear the course, if you are physically able to lecture on consecutive days. In this way you would reach a center of education and investigation in almost every State in the Union, and would have an audience that would thoroughly appreciate a technical and scientific treatment of the subjects you propose.

The following is Dr. Warington's reply:

Your letter of the 6th instant has safely reached me. The information you give is very important. I sent your letter at once to Sir J. B. Lawes in Scotland, but he had returned to Rothamsted before the letter reached him; it will be a day or two before it comes back, and on receiving it Sir John will write to you himself. If the Association of Agricultural Colleges and Experiment Stations which you speak of, is willing that the lectures should be delivered during its meeting at Washington next year, no better course could, I think, be proposed. I should be ready to lecture every day for six days. After each lecture an opportunity might be given, if so desired, for remarks or questions. Will you kindly bring the matter before the Association when it meets at Champaign?

I should also be willing to visit a few other centers such as you have named and to lecture there.

Please tell me if illustrations by means of lantern slides would or would not be desirable. I might bring lantern slides showing Rothamsted House and laboratory, and portraits of Sir John Lawes and Dr. Gilbert. If I lecture on bacteria they might be shown in the same way. The use of a lantern of course necessitates a room that can be darkened.

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HARPENDEN, HERTS, 10, 18, 1890.

Sir John Bennet Lawes has since written the following:

Mr. Warington has given me your letter to him of the 6th of October to answer. He informed me he has accepted the offer of the "Lawes Trust" to deliver the first lecture upon the Rothamsted experiments in the United States in the year 1891, and has requested me to arrange with you, and those whom you are about to meet,

both the time and the locality of the lectures. I understand from your letter that the meeting of the delegates will take place next year in the month of October at Washington, and further, that each college and station is expected to send one or more delegates to the meeting. It has always been our ambition, and, I may say, our aim and object to teach the teachers of agriculture rather than the agriculturists themselves, and I should consider it a great honor and also a great compliment if the invitation were sent to me from the delegates who will represent the stations and colleges of agriculture next year, requesting that the lectures upon the Rothamsted experiments should be delivered before them next year. Although the offer to be the first to deliver the lectures was made to Mr. Warington some time ago, his actual acceptance only took place the other day, and I have had no opportunity of discussing with him the character or scope of his lectures. Should the proposal I have made be accepted, it would be desirable that some one should be appointed to correspond with me in regard to the delivery of the lectures. I have for the last year or two been endeavoring to collect and bind up our various papers which have been published since 1844. I have recently sent a copy to your Department of Agriculture at Washington, and I hope before the end of the year to send several copies to your leading agricultural institutions.

On motion of Mr. Fairchild, of Kansas, this matter was referred to the executive committee of the Association, with instructions to provide for the course of lectures if possible.

The Secretary read a letter asking the Association to appoint delegates to a congress to consider the desirability of a federation of agricultural organizations and to devise a scheme for one. On motion of Mr. Atherton the invitation was referred to a committee of five to be appointed by the president. The president appointed Messrs. Atherton Fairchild of Kansas, Alvord, Flagg, and Scovell.

Evening Session, Tuesday, November 11, 1890.

The meeting was called to order by the president at 8 p. m., in the chapel of the University of Illinois.

Addresses of welcome were delivered by Regent Peabody on behalf of the University of Illinois, and by Hon. G. W. Gere, of Champaign, on behalf of the citizens of Champaign.

Addresses in reply were made by Mr. Dabney, Mr. Brown, and Mr. Atherton, after which the annual address of the president of the Association was in order. President James H. Smart spoke as follows:

Ladies and Gentlemen: In obedience to the constitution of this Association, I have prepared a brief paper of somewhat professional character. It is chiefly intended for the members of this Association, but I hope that it will not be wholly uninteresting to our friends of this city who honor us with their presence to-night. I am unable to read my paper, owing to defective eye-sight, and I have therefore ventured to ask Mrs. Smart to read it for me.

Mrs. Smart then read the address of the President.

Gentlemen of the Convention: I congratulate you upon the favorable auspices under which we meet here to-day. The last academic year was full of promise at its beginning and it justified its promise at its close. The reports from the various institutions recognized in this Association indicate for the most part increased prosperity. The attendance in most of the colleges has been larger than ever before; a higher standard of excellence has evidently been maintained; and in many instances endow-

ment funds have been largely increased either by legislative action or by private munificence.

The experiment stations, called into existence scarcely three years ago, have become firmly established and are already commanding the confidence of the people, for whose benefit they were provided. Three years ago some of us were appalled at the magnitude of the problems which were presented to us by the requirements of the Hatch bill. Forty or more stations were to be established. Forty or more directors of the highest scientific attainments, of the widest experience, of the largest business capacity, and of the most practical common sense were to be selected. Two or three hundred heads of departments, skilled in special lines of investigation, were to be found. Reference libraries of a special character were to be secured, and laboratories were to be fitted up for special lines of work. And this was to be done almost in a day, because our title to the money for the work was not made clear until near the close of the year in which it was to be spent. Some stations, indeed, had been already established and the foundations of others had been laid, but for the most part the work had to be done from the beginning. The fact that so many competent men were to be found to take the various places, affords, in my opinion, the highest proof that the work in some of our older agricultural colleges has been superbly done. It seems to me a marvel that the difficulties which confronted us have been so thoroughly overcome.

I congratulate you especially upon the fact that the institutions represented in this Association have so commended themselves to the general public and to their representatives in Congress as to secure such splendid recognition as was accorded to them in the new Morrill bill, the benefits of which we are about to receive; and I congratulate you also upon having as the chairman of your executive committee a man so thoroughly effective in legislative work, to whom, as I believe, more than to any other, is due the honor of securing the passage of that act.

While no bill could have been pushed through, under the circumstances, that was not thoroughly and cordially indorsed as one of great merit, no bill, whatever its merits, could have been pushed through without the leadership of a great general.

In order to emphasize the importance which this meeting may assume, I venture to express the opinion that both station and college are entering upon a new era, and, as we may confidently hope, an era of great usefulness.

There is need of great reform in the treatment of the soil, in the methods of tillage, in the gathering and curing of crops, in the selection, care, and management of stock, in the preservation of the forests, and in the general management of our agricultural business. Three millions of dollars' worth of crops are destroyed annually by insect ravages, and as much more by plant diseases. The stations will show that much of this enormous waste can be prevented, and they will thus have an opportunity of leading in a campaign of industrial reform which will produce the most stupendous economic results.

I do not doubt that within a few years it will be generally conceded that the stations are showing that they are worth ten times what they cost, and that no movement of the general Government made in recent years has been productive of so much good as the act which established them.

Our collegiate departments, too, have before them a great future. They are leading and will still lead in the great educational reform that has already begun to sweep over this country both in the college and in the public school. I believe that some of the principles which underlie the methods adopted by the approved industrial college of to-day will ultimately prevail in all colleges, whether classical or technical. One of the most important of these may be stated thus: The college curriculum should be so arranged and the methods should be such that the student may receive much of his professional training in the same institution, and at the same time in which he receives his academic training. Or, to state the principle more accurately, the methods of work may be such that a man may receive much of his academic training through his professional training and thus effect a tremendous saving both in time and money.

It is generally conceded that the time now required by the preparatory school, the academic school, and the professional school is too long.

A student at Exeter three years, at Harvard four years, and at his professional school three years will come out at 26 having spent $8,000 or $10,000, and will enter a profession in which he can hardly make for himself a position before he is 30.

The average man does not now take this course, however desirable it may be. He can not take it with safety. It is taken by the few and probably not the best few. The average man, and possibly the best man, takes a short cut. He sometimes omits the professional school, or more frequently the academic school, very often both, and sometimes, I am sorry to say, all three. He will continue to take a short cut; he is forced to do so or remain out of the professions altogether. He will not remain out, and the result will be that the professions—and by the term professions I mean to include all work which may utilize the higher education—the professions will still remain filled with a large proportion of poorly equipped men.

The demand upon the American colleges is for a wider, a better opportunity for the man of average means; an opportunity to become well educated, well disciplined, and to obtain a reasonable professional training, so that he may go out and prove that he not only knows something, but that he is able to do something, and this must be given to him before he is 25.

Can the time now generally required be shortened without impairing the efficiency of the results? A study of the methods and results of the best technical schools will answer the question affirmatively. Let us begin by an examination of such elementary technical schools as are found in Chicago, St. Louis, and other large cities.

The modern manual training school grew out of the necessity for better educated and more skillful mechanics. The old apprentice system, now largely in use in England and until within a few years as largely in use in this country, was found to be a failure, wasteful as to time and destructive as to morals. It is plain to see why it was so.

Let us study the old method a moment. Suppose a boy enters a printing-office, for example, in which he expects and is expected to learn the trade in all its parts. How does he succeed? I once had occasion to frequent a printing-office in which were employed seven apprentices. The proprietor informed me that it would take them at least three years before they could become journeymen. They were to receive an average of 30 cents a day for three years. I found that the boys, although very busy, were spending their time in *not* learning the trade, and, so far as I could learn from inquiry and observation, no attempt was made to give them any systematic instruction. They were engaged for the most part in rude labor, but were permitted to "pick up" the trade, as the proprietor expressed it, as they had opportunity. Now, this "picking-up" process while it is possibly profitable for the employer, is not the most profitable method for the boys.

It results, in the first place, in waste of time. This is bad enough, but it results also in making poor workmen. Need I call your attention to the fact that the country is full of men who pretend to be carpenters and who are not; men who pretend to be machinists and who are not; men who pretend to be pattern-makers, molders, blacksmiths, shoemakers, tailors, and printers, who are shabby, incapable workmen at best? Who that has built a house does not know this? There is not a manufacturer in this country who does not know it, and to his cost, and one of the most difficult things that a manufacturer has to do is to sift out the few really good workmen from those who pretend to know how and do not. The engines that will not work, the machines that wear out, the houses that are shabbily constructed, and the fabrics that fall to pieces will attest the truth of what I say. How many workmen are there who take God's bounty and by careful, skillful, intelligent processes make the most of it? Here is a waste surely. But who could expect better results from a process so full of mischief?

A third result of the "picking-up" process comes from the fact that it fails to

awaken in the boy a keen ambition, without which success in any employment is seldom secured, hence it is that many who enter factories and shops for the purpose of learning a trade, become restless, tired, and discouraged, and leave the business to try another, and thus to become a good-for-nothing jacks-of-all-trades or to join the ranks of the non-productives, and possibly the ranks of the destructives.

In the fourth place the "picking-up" process has a moral aspect. Every handicraft carried to a high degree of excellence may become a fine art. There is no dignity in labor, but dignity may be put into labor. When a man does something that is fine of its kind, whatever the kind may be, it awakens sentiment in respect to the products of even the commonest handicraft. The most valuable man is he who takes rude material and produces something of high value out of it, and who takes pride in what he has wrought.

Some years ago I sent out circulars to employers in some of the industries and in various parts of the country, asking the following questions:

(1) What is the average number of your employés who come to you for the purpose of learning the trade?

(2) How many of these remain with you long enough to become journeymen?

(3) Of those who become journeymen, how many succeed in becoming first-class workmen?

These were sent to (1) carpenters and joiners, (2) pattern makers, (3) molders, (4) blacksmiths, and (5) machinists. From the replies received, and they were numerous, I formulated the following conclusions:

(1) That out of every 10 who enter a carpenter shop with the intention of learning the trade, 4 abandon the business; of 10 pattern makers, 2; of 10 blacksmiths, 6; of 10 molders, 5; of 10 machinists, 6.

(2) Of those who pursue the business and become professed journeymen carpenters, but 3 become first-class workmen; of 10 pattern makers, 2; of 10 blacksmiths, 2½, of 10 machinists, 3½.

We can now construct a table which shows the number of boys out of every hundred entering each trade mentioned, who become first-class workmen, viz:

Carpenters	18
Pattern makers	16
Blacksmiths	10
Molders	17
Machinists	14

being an average of 15 to each 100. Thus it is that the very process we have taken to educate a boy into the various handicrafts is the process by which we have educated him out of them.

Now comes in the manual trainin g school. It offers the boy a good academic education for a period of say 3 years, which is quite equal to that given in other schools. It also offers him instruction in the underlying principles of the great constructive trades with such laboratory practice as will enable him to go from school and obtain work at comparatively high wages. It is shown that by spending 2 hours a day in one of these schools for a period of 3 years the average student may become a fair draftsman, may be instructed in the theory of pattern making, molding, and in machine construction. He may also be so instructed that he may be able to do a first-class job at the bench, in the pattern shop, in the foundry, in the blacksmith shop, and in the machine shop. He knows how to interpret working drawings and can practically make a machine. He has not what is known as speed, but aside from this he is far better off than the average journeyman.

It has been shown quite conclusively that those who stand the highest in the working laboratories stand highest in their academic studies. There is a reason for this. When a boy does a fine thing in one direction, he can be induced to do a fine thing in another direction. When he puts two solid hours into hard work in the shops, he is prepared to go to his room and study with a freshness that enables him to accom-

plish a great deal in a short time. It is fairly claimed that the average student who spends two hours in the shops can do more with a given number of academic studies than one who does not.

But there is another reason, one to which I wish especially to call your attention. Suppose you ask a boy to plan and make the working drawings of a lathe or an engine, and then to make the patterns, then the castings, then to finish and set up the parts and run the machine, what faculties of the mind are not brought into play? The complete machine must be seen from the beginning in the imagination. Its purposes must be perfectly understood. Part must be adapted to part, material to uses. Strength and economy of material must be considered ; the shrinkage and warping of wood and iron under various conditions must be considered; and the question of economy must be carefully studied. The manipulation of every piece at every stage must be understood while the boy is making his drawings. Everything must be worked out with mathematical precision. Every step in the entire process has a very definite relation to every other step. Here is a fine field for the active exercise of the mental faculties. You may be sure that if the machine runs, the thinking has been clear, definite, accurate. The mental habits that are formed by this process should be of the highest value. Experience has shown that they are of the highest value. The student in the manual training school has thus become well educated to a degree, and has become a skillful worker in the great constructive vocations.

Now if we turn to the advanced technical schools, such as are represented in this Association, we shall find that equally valuable experience and equally satisfactory results have also been obtained in the higher departments of technical instruction. It is found possible with the proper standard of admission, to give adequate instruction in most of the usual academic subjects and by the usual academic methods, and in addition, to afford high professional training and practice in applied chemistry and biology, or in civil, mechanical, and electrical engineering, all within a period of 4 years.

It has also been found that the technical and professional work has a tendency to enlarge, discipline, and refine quite as much as the purely academic work.

We may fairly claim, then, that the technical work of our industrial colleges presents something more than a merely commercial aspect. It has in it the highest educational value and provides a kind of discipline not possible through the ordinary academic methods.

Now the American school of liberal arts can not and ought not to become a school of industrial arts, but it can learn much from the experience of the schools of technology. It can omit some of the lesser subjects in its academic curriculum, and include a part of the work that is now left to the professional school. It might thus be found possible to shorten the time 2 years and without serious loss. Indeed I am more than half persuaded that if the time which many of our students spend in college society and politics, and in various other outside enterprises, some of which are wholly destructive, was spent in hard work, 4 years would be quite sufficient for all the academic work and for all the professional work now required by both schools.

Through modern laboratory methods many of our more prominent colleges of liberal arts are working in this direction, but there is still great necessity for reform, especially in the lesser ones. In this connection permit me to refer you to a recent article by President Eliot, of Harvard, in which he advocates the reduction of the academic course to 3 years, and to another by Professor Shafer, also of Harvard, in which he argues, more wisely, I believe, for the introduction of more professional work into the academic course.

There is room for all the better classical colleges we now have. They have done a grand work in the past—they will do a grander work in the future—but the modern technical school, brought into existence in obedience to a popular demand, has come to do a new work required by a new civilization. It comes to deal with a very different man from the one who was born into the world 50 years ago. Since that day the railroad has come in ; the dynamo and the motor have come in ; the modern news-

paper and magazine have come in; in short, the new industrial age—the scientific industrial age—has come in, and the men who are born into it are new men and require new treatment.

The modern industrial school has a special work of its own which will lead it into a broader and broader field of usefulness.

What limit shall be placed upon the demand for men who can move things; who can design new appliances for utilizing the forces of nature; who can supply the material needs of mankind; who can prevent disease; and who can make things grow where they did not grow before?

The graduates of our departments of mechanical, electrical, and civil engineering, and of our departments of applied biology and chemistry are already securing recognition. The demand for them will be larger and larger, but I predict that our departments of agriculture—the schools that do not, in the opinion of many, justify their existence—will send out graduates who will also find a wide field of usefulness.

The question "Who is to feed the coming millions?" is, after all, one of the greatest economic questions of the day. It will be a greater question in the future. The products of the earth are scarcely sufficient to keep us now—not sufficient to make us rich, and the demand of the future will be greater. Who shall show us how to take hold of and solve the tremendous problems connected with agriculture, the greatest American industry—the industry upon which our material prosperity largely depends? Such men are now stepping to the front, and the institutions which are represented here to-day are furnishing them. We may therefore thank God and take courage and go on.

Morning Session, Wednesday, November 12, 1890.

The Association was called to order at 9 a. m. by the President.

Mr. Fairchild, of Kansas, asked whether one person might represent both a college and the station connected with it. After some discussion the Chair decided that no person could cast more than one vote in the general sessions of the Association and referred the question whether one person might represent a college in the section on college work and a station in other sections, to the Association.

The following resolution offered by Mr. Atherton was adopted:

Resolved, That one person may have but one vote in the general sessions of the Association, though appointed to represent both a college and a station; but one person may represent a station in one section, having one vote, and a college in another section, having one vote.

The Secretary read the following letter addressed to the President, by Merrill E. Gates, of Amherst College, formerly president of Rutgers College in New Jersey:

Permit me to present through you to the Association my resignation as a vice-president of the Association. This would as a matter of course follow my resignation of the presidency of a State college; but I avail myself of the occasion to extend through you to my many friends in the Association assurances of the regret I feel in leaving the Association, and of my most hearty good wishes for the success and the growth of that noble piece of popular educational work, industrial, scientific, and liberal, which is intrusted to the State colleges.

Through my brother Goodell, who is a neighbor of mine here, I hope to keep in touch with what is being done by these colleges. And I extend to the members of the Association generally a cordial invitation to remember me when they come to see the

Amherst Agricultural College, and to keep under kindly and scientific cultivation a friendship which to me has been most pleasant.

AMHERST, MASS., *October* 28, 1890.

The letter was referred to the Secretary with instructions to send a suitable reply.

Mr. Alvord moved to amend the constitution by inserting in the section relating to permanent committees the words "on college work" after the words "on chemistry" and before the words "on entomology." The motion was carried by a two-thirds vote and therefore adopted.

The committee to audit the accounts of the Treasurer reported as follows through its chairman:

Your committee appointed to take into consideration the report of the Secretary and Treasurer, would respectfully report that they have examined the report of this officer carefully and compared the receipts, bills, and other papers connected therewith, and find them to be correct.

They would also commend the neatness and arrangement, by means of which the committee was able to transact its business in a very short space of time.

In the line of our work we found that there were some stations and colleges that had not yet responded to the call made by the executive committee of the Association, probably from inadvertence, and we would recommend that the executive committee give all such an opportunity to fall into line at this convention.

Respectfully submitted.

C. L. INGERSOLL,
CHAS. O. FLAGG,
R. J. REDDING,
Committee.

The report was adopted.

Mr. Harris, assistant director of the Office of Experiment Stations in the U. S. Department of Agriculture, then presented the following paper as provided for in the program:

THE AGRICULTURAL EXPERIMENT STATIONS AT THE WORLD'S COLUMBIAN EXPOSITION.

Some time ago the Office of Experiment Stations was called upon by the Assistant Secretary of Agriculture to prepare plans and estimates for an exhibit to illustrate at the World's Columbian Exposition the line of work in which the Office is engaged. After consultation with Dr. Goode, Assistant Secretary of the Smithsonian Institution, in charge of the National Museum, who was at the time preparing a system of classification for the Exposition, the Office prepared and submitted to the Assistant Secretary a scheme which received his approval. This provisional scheme it is my purpose to describe to you to-day.

The plan provides for a coöperative experiment station and Office of Experiment Stations exhibit in connection with that of the Department of Agriculture. It is not necessary to enumerate all the reasons which led us to recommend a coöperative exhibit, but some of them may be rapidly mentioned:

(1) Such a plan will give a large number of the stations their only opportunity to exhibit.

(2) Such an exhibit will be expected by many persons.

(3) This plan, connecting the station exhibit with that of the Department of Agriculture, will call to the exhibit the attention of the farmers of the whole country.

(4) This plan, exhibiting the work of the stations collectively, will insure an unusually large and impressive exhibit.

(5) It will give a better and more nearly perfect demonstration of the enterprise.

It is not proposed that this coöperative exhibit shall in any way interfere with exhibits of individual stations, if desired, in connection with those of their States or colleges. Moreover it is believed that our plan will not involve any great amount of duplication.

General statement of plan.—The experiment station exhibit should be a unit of installation in connection with the exhibit of the Department of Agriculture and should be on a uniform plan contrived and carried out by the Department in coöperation with the stations. In order to distinguish the work of the stations from that of the Department the station exhibit should be in a room by itself. It should show that this enterprise has been recently organized, is national in its scope, and that while the different stations are carrying on their work separately in different States they have definite relation with the Department of Agriculture and with each other through the Office of Experiment Stations. The exhibit should be so arranged that the visitor to the Exposition will carry away a distinct impression of the importance of this enterprise, of the causes which led to its inauguration, and of its possibilities in the future.

Plan for experiment station exhibit.—The exhibit should occupy a separate room, of rectangular shape, 80 feet wide and 100 feet long. At one end there should be a room (80 by 20 feet) extending across the entire width of the allotted space. The remaining space should be divided into a broad central passage, and ten alcoves arranged along the sides.

In the room at the end of the hall are to be laboratories, workrooms, a station library, office, etc., *i. e.* an *experiment station in operation.* In each of the ten alcoves is to be illustrated a special department of station work, *e. g.*, soils, plant growth, dairying. Whatever any individual station contributes to these exhibits of special lines of work, should be labeled so as to give due credit to the station. In the central space is to be a general exhibit of the stations by States, including general facts, statistics, publications, models and pictures of buildings, and exhibits illustrating special lines of work. Here, also, will be the special exhibit of the Office of Experiment Stations.

THE EXHIBIT IN OUTLINE.

(1) *The index.*—As the visitor enters the hall he will see before him a large map (20 feet square) suspended near the opposite end of the central passage. On this map will be represented (*a*) different agricultural regions of the country by means of different colors; (*b*) the locations of the stations and their relations to other institutions; (*c*) references by figures or otherwise to things exhibited by the several stations. By this means the visitor will learn at once in what kind of region any particular station is located and where information regarding that station may be found in this exhibit.

(2) *Laboratories, workrooms, library, and office.—The experiment station in operation.*—The purpose is to have here chemical, physiological, and mycological laboratories equipped with appropriate apparatus and in charge of experts who shall be engaged in actual experimenting. The operations of course will be comparatively simple ones, adapted to illustrative purposes. There should also be a small, carefully selected library of technical books on the science and practice of agriculture and allied subjects. Illustrations of the best methods of mailing publications, keeping office files, keeping mailing lists, etc.

(3) *The alcoves.*—The plan of the exhibit in each of these would be, in general, as follows: At the entrance of the alcove an attractive showpiece illustrating some striking fact or process connected with the subject of the exhibit in the alcove. This would be used to draw attention to the subject and to excite the desire to study the exhibit of the subject more fully. Within the alcove would be cases containing apparatus, products, models illustrating processes, etc.; wall charts and diagrams setting forth in outline the history of investigations in a particular subject, the present state of knowledge on that subject, and the possibilities of discovery in that

line; photographs of buildings, apparatus, and prominent investigators arranged on wing frames. There should also be descriptive placards and leaflets of information for visitors. The general hand-books on the subject should be placed where they could be freely consulted by those who wish to spend some time in studying the subject in connection with the exhibit.

To illustrate what the exhibit in a single alcove may be, let the subject of plant growth and nutrition be taken. Here, as the showpiece near the entrance of the alcove. might be displayed a number of large glass jars containing live plants growing in water under different conditions as to periods of growth, kinds of plant food used, etc. In this way the entire plant, roots, stem and all, might be shown in a very attractive manner. Inside the alcove might be shown by means of colored diagrams, the different processes of plant growth as affected by peculiarities of soil, climate, and treatment. In cases would be specimens showing different stages of growth, chemical composition of plants at different periods of growth, or apparatus used in experiments on plant growth. Pictures of distinguished investigators in this line, and of apparatus which could not be conveniently shown otherwise might be arranged on wing frames as described above. Charts would give in a brief and striking manner much information regarding the progress of investigation in this line. There should also be a "primer" on plant growth and nutrition, with practical suggestions, to be distributed to visitors. On a table conveniently arranged for reference should be a small collection of the best general and special treatises on this subject. Any good work which Americans have done in this line should be clearly brought out, and the possibilities of making this a useful line of investigation by our stations should be enforced. Of course a thorough system of interesting and instructive labels would be indispensable.

Again, take the alcove devoted to soils. Here may be illustrated the classification of soils, their chemical composition, the methods of chemical and physical analysis, apparatus used in studying soils, *e. g.*, soil thermometers, lysimeters, models illustrating systems of drainage, irrigation, and tillage, etc.; the results obtained, some of the difficulties of forecasting crops by soil analysis, and the scope and importance of the work to be done in soil investigation. The possibilities of an exhibit in this line will be seen when we remember this alcove would include such subjects as the chemistry, geology, and physics of soils, drainage, irrigation, tillage, etc.

There will be no lack of interesting subjects to illustrate in the various alcoves. The great difficulty will be to make the best selection from so great a variety of good things. The number of different alcoves should not be so large as to make the exhibit monotonous and wearisome. It is thought that ten subjects will be as many as it is desirable to include in this exhibit. Among the subjects thought of as appropriate and interesting may be mentioned soils, fertilizers, seeds, plant growth and nutrition, feeding stuffs and feeding, dairying, silos, etc.

The exhibit of individual stations in the central passage should be arranged by States and include (1) the publications of the stations in the different States; (2) views of their buildings, charts describing their history, lines of work, and important results of their investigations; and (3) such collections, illustrating improved products and processes, apparatus, etc., as when taken together will show the wide range of station work in its extension throughout the entire country. This exhibit should be arranged along this central passage so that the visitor as he passed from one end of the room to the other would take in at a glance the distinctive features of the several stations and thus get a general idea of the scope of experiment station work, its variety, and what each station is contributing to the enterprise.

Opportunity should be afforded (by means of tables or desks and chairs) for the thorough study of a station's work.

It is hoped that it may be found practicable to have at the Exposition at all times a certain number of experts, selected in turn from all the various stations, who may

be in attendance in the Exposition hall and increase the educational value of the exhibit by explanations, demonstrations, and lectures.

To recapitulate, the exhibit should be a unit by itself. It should consist of (1) a central exhibit of the work of each station arranged by States; (2) alcove exhibits by topics; (3) an experiment station in operation; (4) lectures, explanations, pamphlets, and labels.

Of course such an exhibit is impossible without the coöperation of the stations. About two years remain for preparation. Of these, fully one will be needed for the development of detailed plans. It must first be decided whether the stations care to enter into any plan for a coöperative exhibit. It is hoped that this Association may feel itself competent to take such action as will justify the Office of Experiment Stations in energetically entering upon its work, and that the Association will appoint the necessary committees to act with the Office.

At the conclusion of this paper, Mr. Peabody, Regent of the University of Illinois, invited the Association to take a recess for a few moments to attend the chapel service.

On motion of Mr. Atherton, the consideration of the paper presented by Mr. Harris was made the special order for 4 o'clock of the same day, and on motion of Mr. Hadley the Association took a recess of 20 minutes.

At 10:30 the Association reassembled.

Mr. PEABODY. I would like to announce that arrangements have been made to provide accommodations for those who desire to go from here to Chicago to visit the Fat Stock Show. The State board of agriculture will very highly esteem a visit from this body.

On recommendation of the executive committee as a committee on order of business, the Association adjourned to allow opportunity for meetings of the permanent committees.

AFTERNOON SESSION, WEDNESDAY, NOVEMBER, 1890.

The Association was called to order at 2:15 p. m. by the President.

Mr. ALVORD. According to the program, this afternoon from 2 until 5:30 is to be devoted to the general session of the Association. It is true that according to the requirements of the constitution we are to consider topics of a somewhat special character to be presented by the permanent committee on horticulture, but it is the evident intent of the constitution that these meetings should be attended by all the delegates of the convention. But notwithstanding this, and the fact that the program provides what is deemed sufficient time for meetings of the permanent committees, some of these committees are, as I am informed, in session at this moment. I suggest that a messenger be sent by the President to inform these committees that they are sitting unconstitutionally, and to request all delegates to come to the general session; and I further suggest that the President read to such delegates a constitutional lesson if that seem necessary. It certainly was intended when the constitution directed that at least two of the permanent committees should each year present topics before the Association in general session, that all persons attending the convention should be present to listen. The agriculturists, chemists, and entomologists have a right

to be heard in their turn, and it is only proper that they should listen when other committees present matters of interest and importance.

Mr. Alvord for himself, but disclaiming to act for the executive committee, moved that a messenger be appointed to request the attendance of persons attending sessions of permanent committees. The motion was carried and the President requested the Secretary to courteously notify the chairmen of the various committees in session that the convention was ready for business and awaiting their attendance.

Mr. Atherton, chairman of the committee appointed to consider the question of a representation of the Association in the proposed pan-agricultural association or convention, asked leave for his committee to meet at 3 o'clock, during the general session of the Association, stating that this would be a convenience, but that he hoped the request would be denied if thought likely to be a bad precedent. On motion of a delegate, the request of Mr. Atherton was granted.

Mr. Alvord reported from the committee on credentials that 30 States were represented by 105 delegates and other persons in attendance, and that these persons represented 72 colleges and experiment stations and the U. S. Department of Agriculture (see p. 15).

Mr. Goff spoke as follows on "The work of the experiment stations in the reform of vegetable nomenclature:"

I had supposed that Professor Bailey would treat this subject, and I was not informed otherwise until after I had arrived here. I will give a brief report of the work of the committee on this reform, appointed at the Columbus meeting of horticulturists more than a year ago.

One of the things which it seemed desirable for the committee to undertake was the simplifying of the names of vegetables. All of you who have given any attention to the subject know that the nomenclature of the vegetables is in bad condition. The American Agricultural Society has undertaken a revision of the names of fruits, and the committee has undertaken a similar revision of the names of vegetables. The committee, in its work, has acted upon the principle that "a name is bestowed upon any plant solely for the purpose of designating it." In other words it has endeavored to make every name as short and simple as possible, and yet avoid confusion. It has been thought best in this list to keep separate all names which have been independently applied to varieties, and therefore no attempt has been made to determine synonyms. The five rules adopted by this committee, governing the form of the names and forming the basis of all changes, are:

(1) The name of the variety should consist of a single word or at most of two words. A phrase, descriptive or otherwise, is never allowable. (2) The name should not be superlative nor bombastic. (3) If a grower or dealer has procured a new select strain of a well-known variety, it shall be legitimate for him to use his own name in connection with the establishment of the variety. (4) When personal names are given to varieties, titles should be omitted. (5) The term hybrid should not be used, except in those rare instances in which the variety is known to be of hybrid origin.

It is impossible to make all published names of vegetables conform to the above rules, which are of necessity ideal, designed to control the making of new names rather than for the reformation of old ones. The committee has made all changes thoughtfully, and yet it is aware that its work may be often open to objection. In such cases it desires the advantage of any honest criticism. In the application of the code, many minor rules have been drawn, but there are many instances in which no

rule or precedent could apply and purely arbitrary decisions were necessary. The following minor rules will explain the attitude of the committee:

(1) In all the revision the committee has simply modified the existing names; no new words have been introduced. (2) So far as practicable, it has selected for the proper name the one most important word in each customary appellation. (3) There has been no attempt in the name to give credit or honor to any person; the purpose of the name is to designate the plant and all other considerations are extraneous. If the originator or introducer desires to associate his name with his product, the proper way is to give the plant simply his name, omitting the burden of adjectives. (4) In proper names the possessive case has been omitted, and the name, if allowed to remain, stands in apposition or as an adjective. The only departure from this rule is in the case of new strains of old varieties (see rule 3 in code). Thus in peas, *Laxton's Prolific* becomes *Laxton Prolific*. Here the personal name would have been dropped altogether, only that the term *prolific* is so much used and abused that it means nothing by itself; and to have used the personal name alone would have added confusion because there are several other Laxton peas. (5) The word *seedling*, which is meaningless in this connection, is always dropped and the personal name attached to it becomes the name of the variety. (6) In the case of a few old varieties which are now little grown, it has not seemed worth while to attempt to revise the name. An example has been found in *President Garfield's Tomato*, which, it is to be hoped, will be forgotten before any new name could be learned. (7) All descriptive adjectives have been omitted whenever the change would not be likely to lead to confusion. In some cases, however, three of these adjectives must be retained in order to distinguish the variety, as *Dwarf Round Purple* and *Large Round Purple egg-plants*. Dwarf and large are necessary to distinguish the varieties from each other, round is necessary to distinguish both from the *Long Purple*, and purple distinguishes them from the *Long White*. (8) In phrases which could not be shortened to a word, the connection is usually dropped or, in rare cases, the phrase is transposed: *First in the Market* has been made *First Market* and *Champion of America* becomes *American Champion*.

The committee is aware that its labor is largely self-imposed and that it is in no manner dictatory; but if it shall succeed in inspiring " brevity, accuracy, and good taste in the naming of vegetables" in the future it will have done enough.

Mr. ALVORD. I would like to inquire whether it is proposed to publish this revised list.

Mr. GOFF. It has been published, but I believe not officially. Mr. Green will know.

Mr. GREEN. It has not been published officially because there is much more work that ought to be done on it, but we wish it so published when complete. This is simply a report of progress which we make in order to call the matter to general attention, as the list may be of use even now. It should be noticed that the committee has not attempted to carry its reform into the domain properly belonging to the agriculturist. Nothing has been done in regard to the names of varieties of corn and wheat.

Mr. ALVORD. Has the committee included potatoes?

Mr. GREEN. It has.

Mr. ALVORD. I suggest that this list when revised should be used by the stations and colleges generally, and that the list when completed or advanced far enough to be useful for temporary purposes, should become the property of the Association to be incorporated in these proceedings or in some special publication. It will then be recognized

as having the authority of this body. If it appears simply in a periodical connected with our work it will not have the same effect, notwithstanding the fact that one of the leading workers in horticulture is the editor.

Mr. ATWATER. Allow me to say that if the Office of Experiment Stations can be of use in the dissemination of a matter of this sort it will gladly offer its services.

Mr. ALWOOD. This committee has done its work most faithfully, and the result of its labors is of great importance not only to the station horticulturists, but to all workers in horticulture throughout the country. I wish to indorse the views of Major Alvord in regard to the desirability of having the report published. I therefore move that the report of this committee and the revised list be printed officially and distributed through the Office of Experiment Stations at the earliest possible date.

The motion was adopted.

Mr. MASSEY. I would like to ask whether this committee proposes to deal with the question of synonyms. It seems to me very desirable that it do so, as great confusion exists in regard to synonymous names for vegetables.

Mr. GREEN. That work was not given to this committee. Its work, however, is preparatory to the subject of synonyms, as a revised list of the sort that the committee is preparing is necessary for intelligent work. This committee did not feel authorized to deal with this question nor capable of doing so. No three persons could do all the work required. It will be a long, tedious work, requiring coöperation.

Mr. LYON. The work of this committee is like that undertaken by the American Agricultural Society, which has had great trouble arising from the fact that its action has not been generally followed. Indeed, nurserymen universally use the old names and great confusion follows. I wish to inquire, therefore, whether this committee has any reason to hope for better results from this work.

Mr. GREEN. We can not compel anyone to use our list, but it is a matter of convenience to the horticulturists of the stations to have such a list, and if they will use it we think that some progress will be made towards a reform. We do not expect that seedsmen will at once take it up, but by persevering we hope to bring them to adopt our views, and I feel confident that many will do so soon. The greatest trouble will arise in cases where a seedsman's name and trade-mark has been cut out.

Mr. Green, of Ohio, being called upon, presented the following paper on "Methods of work in variety testing:"

Variety testing is by no means a difficult kind of experimental work, and yet but little has been done by the stations that shows a mastery of the subject. This arises largely from a misconception of the ends to be attained. It is a mistake to suppose that a botanical study of varieties completes the task. It is well to study varieties from a botanical standpoint, and to arrange them into groups or classes for convenience

in order to determine synonyms, but this is merely the beginning and not the end of the work. It is the road along which every one must travel who would make a variety test of any class of plants. This road ends in the field or garden, where a conclusive demonstration must be given before the task is completed. The problem is not only to determine characteristics of varieties, but to demonstrate the existence of these characteristics as well. On the other hand, a satisfactory field test of varieties can not be made without a preliminary study of characteristics, mainly from a botanical standpoint. One can not read until he learns the alphabet. The A B C in this case means a thorough knowledge of the varieties with which one is working. After this knowledge is gained, and not before, comes the comparative and decisive field test. In fact, one must become an expert in varieties before he can test them. He must know them as well or better than a botanist does species, or the gardener does his pets. He must study varieties not only to learn what they are, but what they are good for; in fact, must take the utilitarian standpoint of view with the farmer and gardener.

A variety trial can not be made in a single season by any but an expert, because the ground can not be covered in that time. Even if one trial were conclusive it takes several seasons to work up to it. When this preliminary study is concluded and the work with any class of plants is to be commenced, the first thing to do is to reduce the list to the smallest possible dimensions. The mistake of the novice is to make the list of varieties as long as possible. This is proper and essential in preliminary work, but in a comparative test too many varieties overtax the observer, and in a report distract the attention and confuse the reader. Synonymous sorts must be rejected, also those that are similar, unless the design is to show their similarity. Old varieties that have been discarded and new ones not known to the public, unless of uncommon merit, must be thrown out.

Varieties that are not well fixed and are known to be variable, have no place in a comparative test, as they are likely to obscure results and to bring discredit upon the whole work. The best or leading varieties of all classes of plants show but little variation. One or more of these should be selected as a standard for comparison in each trial of varieties. Further selection is to be governed by the end in view, but the fewer the number of varieties the better. Seldom will the list need to exceed ten for any one class of plants, and less than that number is better than more, even though a seeming sacrifice must be made.

There is danger in attempting to cover too much ground in variety work, not alone by including too many species and varieties, but in endeavoring to make too many comparisons at one time. In nearly all experimental work there is danger of being drawn aside from the line of investigation first proposed, and in variety testing the temptation is peculiarly strong because it seems so easy to cover just one point more, and we are apt to persuade ourselves that it ought to be done.

If varieties are to be compared as to earliness, one and sometimes more are taken as standards, and such others are added to the list as may be required to carry out the object in view. In the same manner comparative productiveness or any other quality is determined. In each case different standards of comparison are used, and a new list of varieties taken.

If one character or quality in the various varieties is compared and studied at a time, the work is simple and easy, but it becomes complicated and difficult just in proportion as the number of characters investigated is increased. If one undertakes to gather data from which to compile a table of varieties giving date of ripening, size, weight, etc., he is apt to have his vision obscured by the multiplicity of objects before him. He sees nothing clearly, and of course can not make a clear presentation of the facts observed. There is force in concentration and weakness in diffusion.

The particular point upon which to concentrate must be determined with care, for it is useless to expend energies upon the elucidation of something that is well known,

or that which no one cares to know. The investigator must be able to look at the matter from the same standpoint as the practical cultivator of the soil before he can see what is to be done. If he finds nothing of special importance that requires to be investigated, then there is nothing for him to do. He would as well do nothing as to compare and report upon varieties in a general way without bringing out and showing clearly specific points of difference and resemblance. When practical men are asking "Which is the earliest variety of strawberry? Which is the latest? Which is the best for forcing? Which is the best pollenizer? What varieties of the various fruits are best for evaporating, shipping or storing? What varieties of corn are best suited for silage? What varieties of wheat have the stiffest straw?" and numerous other specific questions, it shows that there are some difficult problems in variety work, and what questions should be investigated.

As has been indicated, the kind of information that is wanted is not general, but specific. This is the place where the practical man halts and wavers. It takes him but a short time to work up to this point, but it often requires a long and costly effort to get beyond it. He realizes his needs, but is unable, as quickly as he would like, to gain the knowledge from experience. Not only this, but without the requisite training there are few minds so constituted as to be able to sift and weigh evidence and to decide what constitutes proof.

The experiment station worker may, from inexperience, fail to see what specific questions are to be answered concerning varieties. The practical man can state the problem, and it remains for the trained observer to give clear and conclusive demonstrations. The answering of these specific questions is what really constitutes variety testing. Do one thing at a time and that thoroughly, is the only successful method in variety work. There is one class of experimental work that naturally falls in the line indicated. In cases where plants are subjected to different methods of treatment, as in work with fungicides, insecticides, and in varied methods of cultivation, there arises the question as to unlike effects upon varieties. The same is true of plant diseases. Unfortunately, the importance of this matter has in many cases been overlooked or ignored, but work of this nature can not be considered complete until the effect of varied treatment is noted for all of the most important varieties. The primary conception of such work is not a variety test, but that necessarily becomes a part of it.

As an illustration, some experiments in transplanting onions and radishes have been conducted during the last two seasons. The crop was doubled by this method of treatment with some varieties of onions, while others showed but little gain; hence a variety test was necessary before the result could be announced. Experience with radishes, celery, strawberries, and other crops has been similar. In each case the experiments in special culture were incomplete without the accompanying variety test. It is well known that applications made to the leaves of plants do not act alike upon all varieties of the same species, nor are all affected alike by plant diseases.

The variety specialist will readily determine how far it is necessary to extend observations in this direction, and where work involving special treatment of plants does not come under his supervision his aid will not only save useless labor, but will enhance the value of that which is done by others.

The determination and demonstration of variety characteristics must in most cases be made by actual field trials.

This leads to the consideration of an important matter in variety testing, namely, the size of the plats. For a preliminary study it makes but little difference what size of plat is used. When the number of varieties runs up into the hundreds, as is often the case, the plat must necessarily be small, often containing but a few plants of each variety. In field tests of varieties some new elements enter into the problem which render small plats inadmissible. Plants of some varieties show a marked individuality that vitiates results if small plats are used. It is not uncommon to find a hill of potatoes that yields twice as much as another hill in the same row. Some

strawberry plants show ripe berries several days before others of the same variety along side. These individual differences may produce marked variations in small plats, but have less and less effect as the number of plants is increased. Varieties are not all equally well fixed; some vary more than others; hence a comparison where but few plants are used is far less trustworthy than where number is sufficient to distribute the effect of variability. It has been argued that small plats are less liable to be affected by inequalities in fertility of the soil than large plats. This may be true and it may not. In most fields there are small areas of higher or lower fertility than the surrounding parts, caused by a stump rotting away, or a tree having been overturned, or other causes that are unknown. These inequalities of limited areas seriously affect small plats, often greatly increasing or diminishing the yield, as the case may be. These spot variations have but little effect upon large plats.

The results obtained in plat work must be stated in terms familiar to those for whom the work is intended. To tell a practical man how many pounds of potatoes were dug from ten hills does not convey to him the same meaning as to state the yield in bushels per acre. If he learns that the rate per acre was obtained by the use of a large multiplier his confidence in the work is shaken and he may ridicule that which he would admire and use if it were done in what he would call the common-sense way. The practice of estimating yields is a dangerous one, yet with small plats it must be done or the results can not be presented in a manner that is satisfactory to the ordinary farmer or gardener. The best plan is to reduce the number of plats and increase the size, so that in making reports small multipliers can be used or none at all. The nearer that ordinary field practice can be followed the more satisfactory will be the results to both the experimenter and his constituents.

Duplication of plat work is recognized by all as essential, but whether it is better to confine the duplicates to one locality or to carry on the work upon different soil is an open question. On the one hand it is argued that the work can be carried on much better if it is all under one management than if widely separated and intrusted to different parties. The experience in Ohio has been that it is hard to find men who can give sufficient time to such work and bring to bear the requisite ability. Many to whom seed or plants are sent do not report, and those that do overlook very many important details. We have had some very fair reports, but many others that could not be used for want of details or evident inaccuracies. With the very greatest of care in selecting men for such work, only a small per cent will give reports of sufficient value to warrant publication. Possibly with more careful supervision, such as could be given if frequent visits were made to those with whom the work was intrusted, satisfactory results could be obtained in this manner. The argument is used that varieties vary so much on different soils that they can not be tested satisfactorily in any other manner. There is just enough truth in this belief that varieties vary according to the soil to make it dangerously false. Fortunately this is not true of all varieties, particularly not of the best. A variety test conducted simultaneously in different localities has less added value on that account than it is commonly supposed to have. It may be more convincing to most people and for this reason is possibly worth the extra cost if properly conducted.

It is best in all experimental work to conduct it in such a manner that it will have the confidence of the people and be convincing, but accuracy and thoroughness must not be sacrificed, for it is not worth while to try to convince the people of something that is not true.

Variety testing can not be put into incompetent hands with any more safety than other work. It requires the skill, patience, judgment, in short all the trained faculties of an expert to carry it on properly. An intelligent farmer or gardener can meet the requirements in part, but not wholly. The work must be laid out and fully explained to him, its progress watched, and the possible errors carefully guarded against. If it is necessary to concentrate upon a definite point in variety tests carried on at the station, it is still more essential when put into the hands of those who lack experience

in such work. The work of a practical man is more to be trusted than his conclusions, but he ought not to be left to himself in work that is to be used for publication. The chemist, botanist, and entomologist may put certain work into the hands of the practical man for verification, but hardly more than that. Why the scientific worker can not intrust more than this to the practical man is evident from the fact that he has had no training in such work. So far as the execution is concerned the practical man would be better fitted to carry on variety tests than strictly scientific work, but his conclusions would be unsafe in both cases. If variety work is put into other hands than those connected with the station, it should be for verification only. The plan of having a few substations in different parts of each State, controlled by the central station and in the hands of trained observers, has proven satisfactory in some cases. No doubt it will in all where properly managed. At least it is much superior to the plan of sending seeds and plants out indiscriminately.

This paper is not intended as a plea in defense of variety testing, but the opinion may be offered that if such work deserves to be continued by the stations, methods must be carefully studied. Like all other work it must stand on its merits. It is too soon yet to say how much merit may be put into such work, but those who have given the matter the most attention say that the case is not hopeless.

A DELEGATE. The reader referred with great terseness to the importance of obtaining conditions as nearly as possible like those of field culture. It seems to me we can not be too careful in this matter. In some investigations in regard to soil moisture, I found a difference of 4 per cent between the amounts of water in the middle and in the edge of a naked strip of 2 feet left between plats of oats 10 feet broad, from which it may be inferred that there was a considerable difference between the amounts of water in the margin and in the middle of the plats. The yield from the edge of the plats was from 28 to 38 per cent larger than that for the interior. It seems to me best, therefore, in order to eliminate disturbing influences which we are unable to estimate with any degree of exactness, to make our tests upon small areas selected from large fields.

Mr. ALWOOD. After eight years' experience in variety testing, I have come to the conclusion that results obtained from plats are not to be relied upon, and have adopted the following method:

I lay off a field of sufficient width to give me plats of the size I desire by taking one, two, or more rows running clear across it. This allows cultivation across the plats, and as no bare spaces are left, avoids the difficulties mentioned of by the last speaker.

Mr. CURTIS. I have very little faith in variety testing, and I would like to ask Professor Green whether it is true that varieties which prove best in Illinois will, as a general rule, prove best for all other States having practically the same latitude and conditions.

Mr. GREEN. I am willing to answer that question in the affirmative as a nearly general statement. There are exceptions, but they occur usually in the case of those varieties which are unreliable anywhere.

Mr. CURTIS. We have in Texas many nurserymen pushing varieties on the market who make a point against Northern dealers on the ground that the varieties from other sections are uncertain because not tested in our climate.

Mr. Green. Climate certainly causes variations in crops, but climate has very different effects upon different plants. The strawberry, for instance, is quite uniform in different latitudes.

A prominent nurseryman in talking with me said that variations due to climate furnished nurserymen a convenient hole to crawl out of when one was needed. They are continually sending out varieties about which they know little, which may prove to be good or may prove to be bad, and in the latter case it is convenient to lay the fault to the climate and soil.

Mr. Alwood. I agree with Mr. Green in the main.

Mr. Massey. I have no reason to disagree altogether with Mr. Green's statements, but we know that there are differences in the same varieties grown with different climates.

Mr. Green. That we will admit.

Mr. Massey. For instance, the St. Atlas strawberry is not of sufficient value to make it conspicuous as a market crop in eastern Maryland, but in North Carolina it is accepted on all hands as a most valuable variety.

The fruit which upon test proves itself bad and worthless in one place will almost always be worthless everywhere. The soil has, however, a good deal to do with certain fruits, and particularly with strawberries. I am of the opinion that moisture supply has much to do with the success of the strawberry, more than either the climate or soil.

Mr. Alwood. I think Professor Massey's selection of the strawberry as an illustration is particularly unhappy, as the strawberry does better under a wide range of latitude and climate than almost any other fruit.

A Delegate. I agree with Professor Green in the main, but his statement that the so-called best varieties are the most reliable is not in accordance with my experience. In the case of the cabbage those varieties admitted to be the finest when grown under the best conditions are notoriously variable and unreliable when grown under ordinary conditions. It seems to me safe to say that the more highly developed a variety becomes the more susceptible it will be to variable conditions.

Mr. Burrill. I want to emphasize Mr. Green's statement of the necessity of great care in variety testing. The first thing thought of by Tom, Dick, or Harry when he decides to make experiments in agriculture or horticulture is to find out whether red apples do better than yellow apples, or something of that kind. If his work is to be of any benefit, it must be critical, given the best of attention, and expert through and through, otherwise the results will be of no value whatever. I believe much of the matter published in this line has been worse than nothing, because it is misleading. In this work, we must raise our ideas of exactness so that our conclusions when obtained shall

be real conclusions. Our work must be so thorough that once done it will leave nothing more to be done.

Mr. REDDING. I judge that most of the speakers have had in mind only vegetables. In Georgia the testing and improving of varieties of cotton, sweet-potatoes, and to a less extent Indian corn, are of greatest interest. The cotton States are, of course, most interested in cotton. This furnishes a wide and useful field of investigation, and if we are to come into a general discussion on the present subject I hope that those interested in this particular line of work will give us what information they can. We are making a series of cotton tests. It seems to us important that the work for the first year should be preliminary, having as its particular object the development of seed to be used in further experiments. I am of the opinion that in testing a given variety all the seed used should be grown on the same stalk, fertilized alike, and in other respects grown under the same conditions.

Mr. FREAR. We should bear in mind the fact mentioned by Professor Green, but not dwelt upon, that varieties are adapted to different purposes and to particular climatic and soil conditions, and when we test varieties we should remember that the same treatment is fair only when applied to varieties especially selected with reference to their adaptation to the conditions under which the test is made. It seems to me that we can improve our varieties very much if we take this point into consideration, although it is very difficult to do.

Mr. ALWOOD. I should like to suggest to the chemists that in connection with this work of variety testing by the horticulturists there is a field for them. What is it that makes one plant more susceptible to certain influences than another? What is it that makes one plant more hardy than another?

Mr. ALVORD. One of the objects of bringing matters from the standing committees into the general session is to make possible their discussion in all their bearings. The Maryland Station has done much work and spent much money in variety testing which has been worthless and has season after season seemed more confusing in its results. We should do less work and do it more thoroughly after the most careful preparation and planning. At our station we have decided to take up one thing, the tomato, and do the most thorough work possible upon it. During the last two years a vast amount of work has been done by our horticulturists with 80 or 90 varieties of tomatoes in field comparison, and laboratory tests have been carried on in a comprehensive manner by our chemist. I judge from reports that similar work has been done in other places.

It seems to me very important to bring about coöperation in this work. If New Jersey and Maryland are to occupy themselves with the tomato, let them work closely together and confine themselves to that line, leaving the cabbage to the cabbage States. We have been talking for 3 years of coöperation, but very little has been done, and it is

time we should come down to business and actually do some coöperative work. A large part of our work for the last 2 or 3 years seems to me to have been a waste of time and money, necessary perhaps in the early years, but showing the great need of close coöperation in the work of variety testing of small fruits, vegetables, and field crops.

Mr. ATWATER. It seems to me that Major Alvord has hit the nail on the head as squarely as can be done. Looking over the work of the experiment stations, as it is my duty to do, I have been most forcibly impressed with the need of more coöperation, and although I can not claim to be an authority in horticulture, this need has seemed to me to be especially great in the work of variety testing.

May I be permitted to make a suggestion? The agricultural production of the United States is one-sided. Our products contain an excess, for the purposes of animal and man, of the fats, and too little of the nitrogenous compounds. We are producing extra fat swine and very fat beef. One reason for this fact is that our great staple crop, corn, is relatively poor in nitrogen and therefore tends to produce fat in the animals to which it is fed. What shall be done? Two things. First, encourage the use of plants rich in nitrogen; second, develop a nitrogenous variety of corn. I think such a variety can be bred by careful selection. Is it not possible that by selecting a variety comparatively rich in nitrogen, taking seed from the ears which show the largest nitrogen content, and following this process through many generations we may eventually obtain a variety of corn suited to our needs? I throw out this suggestion to specialists in this line of work in the hope that they will consider this subject and agree with me that something can be done.

On motion of Mr. Alvord, it was ordered that 10 minutes be devoted to miscellaneous business and reports, and that then the general session be closed in order to give opportunity for meetings of the permanent committees.

Mr. Sanborn, for the committee appointed to take into consideration the recommendations of the executive committee, reported as follows:

(1) That the Association authorize and direct its executive committee to request each agricultural college to contribute $25, and each experiment station $10, to be applied to the liquidation of present indebtedness and the expenses of the Association for the coming year, and urge upon said institutions the importance of making these contributions early in the year 1891.

(2) That no college or station shall have a membership in the Association or enjoy its privileges until it has made contribution to its funds.

(3) That it is the sense of this Association that the Office of Experiment Stations of the Department of Agriculture can be and should be of assistance to the several stations of the country, by the preparation of indexes to station bulletins; by the purchase of periodicals; by the preparation of special record books; by keeping a record of applicants for positions at the stations, together with their recommendations, and of stations desiring workers; and in general by becoming in part, in the interest of the economy of both funds and time, what it has by some been designated, a clearing-house for the common interests of the stations, whenever common interests can be advantageously served.

We respectfully request of the honorable Secretary of Agriculture a consideration of the interest involved, and if the purpose is found feasible, the issuance from the Office of Experiment Stations of a circular defining the directions in which assistance can be given and requesting a statement of the needs of the stations in the field outlined.

(4) This Association hereby directs its executive committee to call its next annual meeting at or near the time and place designated by the American Association for the Advancement of Science for its annual meeting, and that the secretary of the Association be directed to most respectfully request the several associations in the country engaged in the development of agricultural science to hold their annual meetings in such connection with the several associations meeting at the time specified that those interested may attend the meetings of each of the associations in question.

It should be stated that one member of the committee, Mr. Plumb, did not agree with the majority in regard to the fourth article of this report. Mr. Plumb stated that he objected to the fourth recommendation because he thought it desirable for the Association to hold its meetings as often as possible at an agricultural college or experiment station.

Mr. Sanborn called attention to the fact that for a large number of persons attendance at the meetings of the Association involved a long journey and a considerable outlay of money; that a large number desired to attend both this Association and the American Association for the Advancement of Science, and that this could be done in very few cases unless the place and time of meeting were the same.

Mr. Fairchild, of Kansas, said that by adopting the plan outlined in the fourth recommendation of the committee, persons attending this Association would be able to take advantage of the reduction in railroad fares obtained through the agency of the larger association.

The first paragraph of the report was read and adopted.

The second paragraph was read and it was moved and seconded that it be adopted.

Mr. Redding moved to amend by inserting the words "in arrears" after the word "station," making the resolution read, "That no college or station in arrears shall have membership," etc. The motion was seconded.

The President remarked that some stations were in arrears because no meetings of their board of directors had been held since the assessments on them had been made. He thought there was a disposition on the part of most of the colleges to pay, and thought it would be a matter of regret if any were cut off from membership because their governing boards had not been called together in special session. He said there might be some which had paid their assessments for a number of years but were in arrears at the time.

Mr. Turner stated that he had received no notification of the last assessment upon the institution he represented until a very short time ago; that he had then sent his personal check to the treasurer because the bill could not be paid from the college treasury until approved by the trustees.

Mr. Sanborn stated that these facts had been considered by the

committee and had led them to prefer the second article as reported, and that the committee had further thought the obligations to several individuals incurred durng the last winter, so honorable and so binding upon the members of the Association that the amendment would be unnecessary.

The amendment was withdrawn.

Professor Armsby read the following article from the constitution and urged that the resolution would be unconstitutional:

At any regularly called meeting of the Association each college established under the act of Congress approved July 2, 1862, and each experiment station established under State or Congressional authority, and the Department of Agriculture, shall be entitled to one delegate.

Mr. Curtis moved to amend the report by striking out paragraph 2.

The President stated that the motion before the house was to adopt the paragraph, and that in order to accomplish Mr. Curtis's object the pending motion should be voted down or laid upon the table.

Mr. Curtis doubted whether colleges had a legal right to pay the assessments made.

Mr. Atherton thought both the resolution and Mr. Curtis's proposition went too far; that the importance of the matter under consideration should be authoritatively urged upon delinquents by the executive committee in the name of the Association, and suggested that the motion to adopt be voted down and the executive committee instructed to make an urgent representation to the colleges and stations in arrears of the work of the Association and the necessity for contributions.

Mr. Sanborn said the committee believed the resolution recommended would be of great use in strengthening the hands of the executive committee, and of the presidents and directors of the delinquent colleges and stations in obtaining from their governing boards the necessary appropriations to discharge their obligations to the Association. He thought no institution could honorably expect representation unless it bore its share of the expenses.

Mr. Porter asked what part of the Hatch act or of the act of 1862 authorized governing boards to make the appropriations necessary.

Mr. Curtis said he was embarrassed by the question raised by Mr. Porter, but appreciated the force of Mr. Sanborn's statement, that each institution was in honor bound to bear its share of the expenses. He objected, however, to anything which seemed like an attempt to drive members into an honorable course, and believed that if the treasurer called attention to the condition of the treasury delinquent institutions would find some way to pay their dues. He therefore moved that the motion before adopted lie upon the table. The motion was seconded and adopted by an ayes and noes vote of 27 to 9.

The third paragraph was then read and after remarks of approval by Mr. Atwater and others, was adopted.

The fourth paragraph was then read.

Mr. Atherton. Do I understand this resolution to apply to next year only or to all future meetings?

The President. To next year only.

Mr. Scott. In order that we may vote intelligently, I desire to say that it is my purpose to invite the Association to meet next year at the Ohio State University and the Ohio Agricultural Experiment Station.

Mr. Thorne. I wish to second the invitation most heartily.

Mr. Jenkins. I have a very decided preference for meeting in the West and not in connection with the American Association nor at the same time. While I should appreciate the instruction and pleasure attendant upon meeting with that body of scientific men, it seems to me that we should lose by such an arrangement more than we could gain. We meet for business purposes. We would waste our forces in combining with any other association. There would be too many ways in which time might be employed. For myself I should much prefer to bear the extra expense of making separate trips to the different meetings. [Applause.]

Mr. Massey. I am authorized to request this Association to meet next year in Raleigh, North Carolina. The selection of this place would solve all difficulties, for those who desire to attend both meetings could do so at very trifling expense.

Mr. Sanborn. It was not proposed by the committee that the meetings of the two associations should occur upon the same days. If the meeting of the American Association was held in the third week of August our meeting could be held in the second or fourth week.

Mr. Plumb. This Association has recommended the stations to send to its meetings as many of their workers as possible. If we meet in August, which is a very busy time, but few station workers will be able to attend. Moreover, as that time falls in the college vacation quite a number of college men will be in Europe or in other places, from which they can not come to the meeting. Furthermore, if the meeting be held in connection with that of the American Association business will not be transacted with celerity and but poor attention will be given to it.

Mr. Alvord. As the suggestion under discussion originated with the executive committee, allow me one word. The original plan, intended to apply to next year only, contemplated holding the meetings of all the associations which members of this Association would like to attend at some one place, that place to be Washington, and the time to be so arranged that no two meetings should conflict. It was thought that this would tend not to diminish attendance, but to increase it largely, and to afford facilities which could not be obtained in any other way. Furthermore, our action will not fix the date or place of the convention absolutely, for the constitution reserves the final decision of this matter for later action by the executive committee. The fact that one other association in which many of us are interested is to meet in Washington

may not be sufficient to lead us to meet there, but if it should prove that three or four associations which many of us are likely to attend next year meet in Washington on consecutive weeks or days it will be well, as the executive committee thought, to fix the time and place of our meeting so that our Association can coöperate in a general meeting. I understand that one member of the executive committee has already suggested in correspondence with Professor Warington, of Rothamsted, England, that the convention would next year meet in Washington.

Mr. SANBORN. We have never had a representative from the Pacific Coast. I think the plan would bring representatives from California, Washington, and Oregon.

Mr. JENKINS. The statement that it is not intended to hold our meeting at the same time with other associations quite changes my views. But there is one other matter which we need to consider, the temperature of the city of Washington in August.

Mr. SCOTT. If you want a comfortable temperature in the middle of August, come to Columbus. You can run over to the American Association at Washington in a night.

Mr. ATWATER. I have spent the larger part of two Augusts in Washington, and I have suffered less from heat there than I did at Philadelphia or Indianapolis in attendance upon meetings of the American Association.

Mr. THORNE. Is it not worth considering that this arrangement would give us good railroad rates?

Mr. MASSEY. There will be very little difficulty in getting cheap rates to Raleigh.

Mr. HADLEY. New Mexico has been expecting this Association to meet in Santa Fé next year—a good place, half way between the Atlantic and the Pacific.

Mr. ATHERTON. The plan of meeting in Washington every second year has seemed to me and to others, as I know, a good one, for the reason that it would bring together men from all parts of the country to that city where they might be in consultation with the Departments of the Government, and with members of the two Houses of Congress when legislation might be pending or when questions affecting us might be before Congress. But this proposition does not afford us this advantage, as the meeting is to be held not in November or December, when Congress is in session, but in August. I agree perfectly with Professor Plumb that the Association has done its best work, except the business done at Washington with reference to matters of legislation, at the meetings held at the stations. And I must beg to say that if our friend, Professor Atwater, had been in Washington during the session of the legislative committee last summer, he would have found it hot enough. For the present and until we get well upon our feet, I am very strongly

inclined to think that we shall do better to pursue our own course, meet in our own places and in our own time.

Mr. CLUTE. It seems to me that the gentleman who has just spoken has struck the key note. Our Association meets for work for which our colleges and experiment stations pay our expenses. It seems to me that if we go to Washington in August, a time when there will be a great deal of interest and a great deal of excitement there, we shall accomplish but little.

Mr. ARMSBY. I desire to call the attention of the convention to the following provision of the constitution:

> The executive committee shall determine the time and place of the meeting of the Association.

Of course the Association is competent to determine the place of this meeting. But I wish to suggest that this matter should not be so definitely fixed that in the case of some unforeseen combination of circumstances the executive committee may not have power to act.

Mr. SANBORN. The resolution is only an expression of the sense of the convention. If, in the judgment of the executive committee August proves to be an undesirable time, the executive committee will still have power to determine a time and place.

On a vote, the fourth paragraph of the report of the committee was lost.

Kansas City, Missouri, and Fort Collins and Denver, Colorado, were suggested in addition to the place mentioned before as places of meeting.

After some discussion, Mr. Atherton moved that the entire matter of time and place be left to the executive committee. Mr. Northrop, in seconding the motion, gave the Association an invitation to meet at Minneapolis, Minnesota.

The motion was carried by a vote of 31 to 15.

Mr. DABNEY. I move that the executive committee, in preparing the program for the next convention, provide for a session one day longer than the present one. My reason for this motion is that the permanent committees have not had time to transact their business. Some of them have had but one short meeting. It seems to me that we should take the whole of a week for the work that calls us together. The time has certainly come for an increase of one day.

This motion was carried.

Mr. CLUTE. I move that the executive committee be requested to omit addresses of welcome and responses from the program.

The motion was lost.

Mr. ALVORD. It was hoped that the permanent committees might hold meetings this afternoon, but it is now so late that it can not be done. I therefore suggest that we devote the whole of to-morrow morning from 9 to 12 to such meetings. Dr. Armsby proposes that he

read his paper prepared for the general session before the chemical section. He states that it is very technical in character and that he will be entirely satisfied with the change. I now move that a committee of five on nominations be appointed by the chair. The motion was carried. The President appointed Messrs. Fairchild, of Kansas, Broun, Stockbridge, Curtis, and Pettee.

Mr. SCOTT. The executive committee at its meeting held yesterday, thinking it proper that the Association adopt some resolutions in regard to the resignation of President Gates, requested me to draft a minute, which I now offer:

Whereas Dr. Merrill E. Gates, by his resignation of the presidency of Rutgers College and the New Jersey State College of Agriculture and Mechanic Arts, has severed his connection with this Association:

We therefore desire to place on record our high appreciation of his ability and character, our sense of loss at his retirement, and our gratification at the merited distinction he has received in his election to his present position as president of Amherst College.

The Secretary is hereby directed to transmit a copy of this minute to Dr. Gates.

The resolution was unanimously adopted.

Mr. Harris called for the consideration of his paper on college and station work at the World's Columbian Exposition, which had been made the special order for this time. He suggested that the matter be referred to a committee for consideration before being taken up for general discussion. Mr. Dabney moved that a committee of five station directors be appointed to consider the matter and report later.

The motion was carried, and the President appointed Messrs. Armsby, Alvord, Tracy, Ingersoll, and Scovell.

Mr. PATRICK. I wish to say a word in regard to the programs. There are many here whose interest is almost entirely confined to special lines of work. I am a chemist, but I am obliged to attend all the general sessions of the convention, where we have had much horticulture and other things not particularly profitable for chemists, but no chemistry. I suppose the same is true in regard to the entomologists. I rise to protest against the regulations which require the attendance of specialists at the general meetings, instead of allowing them to meet in permanent committees. I know that others feel as I do.

The PRESIDENT. I am of the opinion that it would be a great mistake to divide the Association too completely. I am interested in all sections and would like to be everywhere. We need to get together and learn of each other to learn of the work of other departments as well as those in which we are working. Nevertheless, while in general I approve the present plan, I favor an arrangement of the program which would give more time to the permanent committees.

Mr. ALVORD. Allow me to call attention to the difference between our present program and those of previous years. If you notice them you will see that we are adjusting ourselves to the circumstances under which we meet. When we began we had general sessions only. This

year the larger part of the time for the meeting is assigned to consideration of special subjects. Next year we shall add another day to our session, and I feel certain that ample time will be found to cover the whole field.

Mr. PATRICK. The addition of another day will doubtless relieve the troubles of which I spoke. The fact is, however, that up to this time the chemists have had no opportunity for work. The permanent committee met last evening long enough to organize, but no papers have yet been presented. The entomologists feel as I do, although they make no protest. The committee on entomology, however, at times assembling under another name, holds its meetings right through the general sessions. This shows that the feeling is general that the workers have come here to meet men in their own line and not to listen to discussions in other lines. I move that the executive committee be requested to so frame the program for the next convention that workers in special lines may have ample time to meet together for technical discussions.

Mr. ALVORD. I understand that to be in exact accord with the program as printed.

Mr. RILEY. I am in favor of the motion as made, or at least of the suggestion which it embodies. The entomologists have realized the difficulties growing out of the fact that in general sessions the special discussions have taken lines of but little interest to them. We do not wish, however, to antagonize the officers of the Association. So far as I am concerned I would much rather abandon shop and listen to something outside of my specialty, but others feel differently and wish to discuss questions in their own fields of work. They feel that the time given for such discussions has been too short. But now that another day is to be added to the convention the problem will be solved. The entomologists have been considering this matter and a committee has been appointed which will doubtless make a request to the Association this evening for some action next year in the way of a change in the program so as to permit greater freedom on the part of the permanent committees. I hope the tendency will be in the direction indicated by the former speaker, and that the Association will, like the American Association for the Advancement of Science, make the committees more or less independent.

Mr. ATHERTON. This morning the question was raised whether a delegate could represent college and station at the same time. To answer this question, I submit the following in the form of an amendment to the constitution.

Put a period in the place of the semicolon at the end of line 4. Then insert "The same delegate may represent both a college and an experiment station, and may take part in the proceedings of the sections proper to either or both." After the words "but no delegate shall cast

more than one vote," insert "either in a section or in convention," so as to make the paragraph read as follows:

At any regularly called meeting of the Association each college established under the act of Congress approved July 2, 1862, and each experiment station established under State or Congressional authority, and the United States Department of Agriculture shall be entitled to one delegate. The same delegate may represent both a college and an experiment station, and may take part in the proceedings of the sections proper to either or both; but no delegate shall cast more than one vote either in a section or in convention. Other institutions, etc.

Mr. DABNEY. It is but justice to the executive committee to say that the committee on chemistry has, up to the present time, had two and a half hours for its discussions. If they have not been used, that is not the fault of the executive committee.

Mr. MYERS. All the chemists ought to belong to the Association of Official Agricultural Chemists, in which chemical questions are more fully discussed than can ever be the case in a permanent committee of this Association.

Mr. SCOVELL. I think the program has been as well arranged as possible, and that no fault lies with the executive committee.

Mr. Patrick's motion was referred to the committee on order of business, to be assigned a place on the program.

I further propose that the constitution be amended by substituting the word "section" for the words "permanent committee" wherever they occur in the constitution.

Both amendments were adopted.

Mr. Fernald offered the following resolutions, which were referred to the executive committee for consideration:

Resolved, That the prominence and importance already attained by the cause of industrial education in this country, and its possibilities of future good in all our States and Territories, furnish to its friends and supporters just occasion for congratulation.

Resolved, That the eminent service of the Hon. Justin S. Morrill, of Vermont, not only in its relations to early legislation, by virtue of which the land grant colleges were established, but also in its relations to the recent act of Congress providing for a more ample endowment of these institutions, merits the approbation of all interested in the national welfare.

Resolved, That the Association of American Agricultural Colleges and Experiment Stations hereby expresses its grateful appreciation of the long-continued, faithful, and highly successful efforts of Mr. Morrill in the interest of these institutions, and hereby extend to him the hearty and earnest thanks of the Association for his invaluable services.

EVENING SESSION, WEDNESDAY, NOVEMBER 12, 1890.

The meeting was called to order by President Smart at 8 p. m., in the chapel of the university.

The subject for discussion, "Should this Association take any action in cases where formal charges of misuse of the United States appropriations are made against any college or station?" was by vote referred to the section on college work,

Mr. Stockbridge delivered a short address on the agriculture of Japan.

Regent Peabody tendered to the Association, on behalf of the faculty of the University of Illinois, an invitation to attend a reception at the house of the Regent the following evening at 7 o'clock, which was accepted by unanimous vote.

The Association then adjourned to give opportunity for meetings of sections.

Morning Session, Thursday, November 13, 1890.

The meeting was called to order by President Smart at 9 a. m., in the physical lecture room of the university.

Mr. Alvord moved that the sections be authorized to hold meetings for the discussion of technical subjects, but not for the consideration of business, during the general business sessions of the Association, provided the accredited delegates of the Association are not thereby prevented from attending the general sessions of the convention. He explained that the committee on the order of business believed that the committees which met the preceding afternoon were not authorized to do so, but thought there was no objection to authorizing such a course if attention be devoted to technical discussions only. He called attention to the fact that the official program provided another day for meetings of sections without reports to the general convention.

The convention then adjourned to allow the sections to convene.

Afternoon Session, November 13, 1890.

The Association was called to order at 2:15 p. m. by President Smart. The sections were called upon for reports.

Mr. Tracy, for the section on botany, reported as follows:

> The section on botany has held regular sessions at all times available. The section selected as officers for the coming year, Mr. Halsted, of New Jersey, chairman, and Mr. Thaxter, of Connecticut, secretary. The desirability of securing uniformity in the fittings for spraying apparatus was considered, and after conference with the sections on entomology and horticulture, Mr. Fairchild, of Washington, D. C., was appointed to act with Mr. Alvord from the section on entomology and Mr. Troop from the section on horticulture as a committee in this matter.

On motion of Mr. Alvord, the report was accepted and the officers and the committee confirmed.

Mr. Sanborn, for the section on agriculture, reported as follows:

> The section on agriculture has held meetings on the evening of the first day and this morning. The officers elected are Mr. Plumb, of Indiana, chairman; Mr. Morrow, of Illinois, vice-chairman; Mr. Thorne, of Ohio, secretary. Messrs. Atwater, Morrow, and Curtis were appointed a committee on coöperative experiments with milch cows.

On motion of Mr. Alvord, the officers and the committee were confirmed.

Mr. Dabney, for the section on chemistry, reported as follows:

The section on chemistry has met as provided for in the program, and has held two very interesting sessions jointly with the section on agriculture. Mr. Neale, of Delaware, was elected chairman, and Mr. Woods, of Connecticut, secretary, for the ensuing year.

The committee requests that Dr. Armsby's paper on recent work in digestion experiments be printed in the proceedings [see p. 132].

On motion of Mr. Alvord, the election of Mr. Neale was confirmed, and the publication of Mr. Armsby's paper was referred to the executive committee.

Mr. Forbes, for the section on entomology, reported as follows:

The section on entomology has to report a very successful meeting, in which all the time allowed by the executive committee has been occupied and no more. The chairman elected for the coming year is Mr. Cook, of Michigan.

The following was adopted as a resolution: "The section on entomology respectfully begs leave to state to the Association that the papers presented by its members have been of such general interest, and so much advantage has resulted to individuals (all of which will redound to the benefit of the stations and colleges), that they are encouraged to ask that if possible the program for the next convention be so arranged that more time shall be given for the consideration of special topics by the sections.

On motion of Mr. Alvord, the election of chairman was confirmed and the resolution referred to the executive committee.

Mr. Taft, for the section on horticulture, reported as follows:

Mr. Goff, of Wisconsin, was selected as chairman for the coming year. It was voted to continue Messrs. Green, Bailey, and Goff as a committee on the revision of nomenclature of vegetables, and Messrs. Taft, Butz, and Speth as the committee on the list of originators. Owing to the tendency of nurserymen and seedsmen to give objectionable names to new varieties, it was resolved that in station publications the names used for varieties should be in accord with the rules laid down by the American Pomological Society and the committee on vegetable nomenclature of the section. Mr. Troop was appointed to represent the section on the committee to secure from manufacturers uniform fittings and nozzles for spraying pumps.

On motion of Mr. Alvord, the election of chairman and the recommendations of the section were confirmed. A special vote was called for on the resolution in regard to the names of vegetables, which resulted in its adoption.

Mr. Atherton presented the report of the section on college work, and suggested that as it contained several matters requiring the action of the committee, it be considered in parts.

The section has elected as officers for the ensuing year, Mr. Atherton as chairman, Mr. Peabody as vice-chairman, and Mr. Kern as secretary.

On motion of Mr. Alvord, these elections were confirmed.

In connection with the new Morrill act, the section adopted the following resolutions: *Resolved*, That the college officers should endeavor to bring to the attention of the legislatures of the respective States, at the earliest possible date, the necessary legislative action under the provisions of the new Morrill act, and that until such action is perfected the representatives of the colleges present at this convention

pledge their action and influence to insure an equitable division or impartial application of all moneys received under this act, in full accord with the spirit of the law.

After the addition of a recommendation that the executive committee prepare a copy of the resolutions for immediate distribution to the institutions represented and to the Secretary of the Interior and the Commissioner of Education, the resolutions were adopted.

Another matter which occupied considerable time was Senate bill No. 2779, for an increase to the Engineer Corps of the U. S. Navy. The interest we have in it lies in the fact that the bill provides for the introduction of a limited number of students from technical institutions, such as are represented in this Association, into this corps. After careful consideration the section instructed me to present this resolution with the request that it be adopted:

Resolved, That a committee of three, consisting of the chairman of the section on college work, and Presidents Smart and Dabney, be appointed to urge the prompt passage of Senate bill No. 2779 as one of the means of advancing the interest in the mechanical instruction in the colleges represented in this Association.

Mr. NORTHROP. It is my fault that I was not present at the meeting of the section this morning when this matter was discussed. Had I been there I should have said then what I wish to say now, that I very much doubt the wisdom of the proposed action. We have taken part in agitation for government action in the past very successfully, but wisdom calls upon us to stop somewhere. It seems to me that wisdom teaches us to stop at this point. I suspect that the reason why we are asked to take action in this matter is that there is a possibility of some of the additional force of the Engineer Corps being appointed as instructors in the colleges without cost to them. There is already a law allowing something of that sort, but it has never been administered equitably; it has been the occasion of nothing but favoritism, and I for one want no more of it. [Applause.] I do not believe that the colleges should try to regulate the Engineer Corps of the U. S. Navy, and I think we will be wise to drop this matter where it is.

Mr. ATHERTON. I think I appreciate the position which Mr. Northrop takes, but I am constrained to believe that he is laboring under a misconception. There is a law providing for the appointment of twenty-five engineers and forty other officers as instructors in colleges, but the full number has never been detailed, and many institutions have been unable to obtain them. I am informed that Mr. Northrop has asked for a detail but never succeeded in getting one. I know many others who have tried in vain. I myself did so for five years. The Secretary of the Navy preceding the present incumbent told me that with the increase in the Navy, it was absolutely impossible to spare men from the duties of inspection, the supervision of construction of naval work, vessels, etc. About twenty officers were detailed at one time, but these are being gradually called in. As I supposed this matter would excite no discussion, I did not bring lists with me. In several instances officers detailed have been found so valuable to the colleges that they have been induced to resign their positions in the Navy to accept

salaried college positions. I do not know what reasons moved Congress years ago to order these details to technical institutions from the Navy and also from the Army, but I think almost all agree that the measure was a useful one and that it is our interest and also the public interest to promote legislation of this sort. Naval instruction is not required in our colleges, but in many of them instruction is given in mechanical engineering, of which naval engineering is a part. Our institutions have received from the Navy help in the form of instructors who served without cost to the institutions. It seems but right that these institutions should contribute to the formation of the naval corps.

Again, the Navy, by virtue of the method of its organization—and I must use words that may be somewhat offensive—is something of a close aristocracy. Nothing will serve more effectually to bring the Navy into direct contact with the people of the United States than the taking of engineers directly from our colleges, as proposed by this bill. When a few months ago I found this bill pending I immediately took an active interest in it. I did not at first think it wise to ask this Association to approve the passage of the measure, but on reflection I concluded it right and proper for us to throw our influence heartily in favor of the passage of the law.

Mr. CURTIS. I believe in a good navy and a good army, but I don't believe in this resolution. Four years ago we considered in this Association a measure whose object was to force upon West Point some of the graduates of these agricultural and mechanical colleges, and it will be remembered that the bill proposed permitted detail of U. S. Army officers to the colleges. The measure was defeated, I am glad to say. The only reason that I have heard urged in favor of this detail of military officers is that West Point graduates have nothing to do, and that places must be found for them or damage to West Point will follow. The naval officers are being recalled, but the military officers can easily be obtained.

Mr. ATHERTON. If the gentleman will allow me to interrupt him, I will state that the mechanical engineers' course at Annapolis was discontinued some years ago, so that unless some such provision as that called for in this bill be made, the Navy will soon be without engineers.

Mr. CURTIS. I think we ought not to try to get engineers detailed. It is the business of our institutions to make engineers competent for the work of instruction in our colleges. Among our graduates there are many men quite as successful as teachers as any who have left West Point or Annapolis. We can not afford to go before the people with a record of having discouraged our own graduates.

Mr. DABNEY. Some of us belonging to the section on college work thought the expediency of its action doubtful, and I believe that if those who are now opposing had heard the discussions in the section, they, like us, would be in favor of the resolution. The Navy at present

has no source from which to obtain engineers. The institutions represented by this body though primarily agricultural colleges are also mechanical colleges, are growing stronger and stronger in this part of their work, and are the annual source of supply for the Navy. Moreover, if this bill be passed it will stimulate our students in the mechanical department to greater effort.

I am pleased to note that we are looked to for support. A member of this convention has received this telegram from the Chief of the Bureau of Engineers:

Resolution and appointment of a committee by your Association meet with my hearty approval. Good luck to you ever.

GEO. W. MELVILLE,
Chief of Bureau of Steam Engineering, Navy Department.

Mr. ATHERTON. I would like to say a few words in regard to the matter of favoritism. An instance in point that did not occur to me has been called to my attention by other members. When Secretary Whitney was in the Navy Department he received an application from his father-in-law, Senator Payne of Ohio, for the detail of a naval officer, which was refused.

Mr. Curtis has suggested that we turn out of our colleges every year men competent to give instruction, and that these men should have the appointments in our colleges. My experience has been that such men among our graduates are engaged before they leave us and that we are unable to offer them sufficient pay to hold them.

Mr. SANBORN. I am against the resolution because I think this Association ought not to get into a lobby in the interest of naval officers. I want men for our college as badly as any one, but I would not take them at this price.

Mr. NEILSON. It seems to me that this proposition is a plain business matter. It is universally recognized as important in educational institutions to supply to young men a stimulus for action, and certainly there can be no greater stimulus to the graduates of our mechanical departments than this opening of important positions in the Navy, and there certainly is need for this stimulus. Otherwise the business interests of the country would not so long have been calling for men of thorough mechanical training without finding them.

Mr. STOCKBRIDGE. It seems to me the discussion is drifting from the point. The question that we should consider is not the propriety of the original bill, but the advisability of this Association taking the action suggested. Allow me to recall an incident of our meeting at Washington last year. We were asked as an Association to take action on a bill then pending before Congress to transfer the Weather Service from the War Department to the Department of Agriculture. It was decided at that time almost unanimously that it would be impolitic on the part of this body to take any official action in relation thereto. I wish then to raise the question, whether we should not consider the advisability

of any action by this Association rather than the wisdom of the bill before Congress.

Mr. ALVORD. I wish to call attention to the fact that in submitting this proposition, the section from which it comes had a precedent in the action of this body. At its last convention this Association appointed a special committee to confer with the War Department in regard to the administration of an act which had just passed Congress in regard to the detail of military officers to colleges, and it will be remembered that the action of this committee resulted in an understanding between the colleges represented in the Association and the War Department, which was in its main features similar to the provisions of this bill for carrying graduates of our colleges into the engineer corps of the Navy, viz, the honorable mention of meritorious graduates of the college in the Army Register, with a view, as expressed by the Secretary of War, to ultimately nominating them as candidates for appointment to vacant positions as officers in the Army.

While to some it may appear unseemly in this Association to act in a matter of this sort, I can not refrain from reminding the president of the Utah Agricultural College that twice lately at his personal solicitation I have visited the War Department for the purpose of having an Army officer detailed to his college. If I succeed in my effort, and I shall act under instructions until they are revoked, it will be because the influence of this Association secured the passage of the bill by the Fiftieth Congress increasing the number of officers to be detailed from the Army to the colleges and giving the colleges represented in this Association first claim on the War Department for the detail of its officers. [Applause.]

Mr. SANBORN. Major Alvord's diplomacy is greater than his logic. The act of 1862 placed upon us the obligation to teach military tactics and placed upon the United States the obligation to supply us with military officers.

Mr. DABNEY. It also obliged us to teach the mechanic arts.

Mr. SANBORN. It is our right, to be sure. I move an indefinite postponement.

Mr. SMART. This bill has a direct bearing upon our institutions. It is in a sense an educational bill, for in one of its most important provisions it touches vitally the interests of the colleges here represented in that it provides that students graduating from our institutions may upon competitive examination be admitted into the naval service. It is therefore a proper bill for us to consider. We have been asked by authorities at Washington to consider this matter, but that request should not be looked upon as an imposition, for the matter is one of vital interest to ourselves. Notice, if you please, that there is not one word in the bill in regard to detailing officers. That is entirely an outside matter. There is an act by which the Secretary of the Navy is permitted to make details, and he has made them for many years and

will continue to have authority to do so, and we have nothing to do with the act. This is a bill to provide the means for the further education of our young men.

I do not care to discuss this matter fully, but simply to call attention to the fact that this case is not parallel to the one mentioned by Dr. Stockbridge regarding the transfer of the Weather Service to the Department of Agriculture, a matter with which we had nothing to do, whereas this is a bill of vital interest to our colleges. We have, therefore, a perfect right to consider it.

Mr. ATHERTON. Some things said here seem to indicate that there is a feeling that the college section is asking this Association to pass upon a matter of which it knows nothing and which it has not discussed. Allow me to say in justification of that section that as the question related entirely to the administration of the colleges and did not touch the experiment stations, either directly or indirectly, it was thought that the matter was a proper one to bring up in meetings of the college section, at which, it was assumed, all gentlemen interested in college work would be present. The section discussed the matter fully. Copies of the bill were at hand and all details were carefully followed, and only two or three gentlemen present expressed any doubts of the advisability of the action taken. I do not mean to dissent from the final conclusion which may be reached upon this resolution, but simply to relieve the section which I represent from the slightest suspicion of any attempt to bring undigested matter before this Association with a request for its approval.

Mr. FAIRCHILD, of Kansas. In justice to myself as a member of that section it is proper that I should say that my sympathies are with the statement of Dr. Northrop.

Mr. NORTHROP. May I say a further word in explanation? I hope no one will think I am making any factious opposition or that I have any particular feeling in this matter, for I have none whatever. I will tell you frankly what lies in my mind. We have just come out successfully from a long struggle to carry through Congress the Morrill bill. It is a most surprising success, and the passage of the bill by the Senate and the House is a matter of congratulation. But it is not a measure which has received unanimous applause throughout the country, and in more than one board of regents will be found intelligent and far seeing men who criticise Congress for doing what it has done. Gentlemen having more intimate acquaintance with this Association than I have, think there may be trouble ahead; that we are to be watched and closely criticised. My thought is this: Let us not put ourselves in a position which will allow the country to say that we are insatiable in our demands; that not satisfied with $15,000 a year, with an annual increase of $1,000 each year until the sum reaches $25,000, we are now entering into a compact with certain officers of the Navy to secure the passage of a bill which will provide further for ourselves and graduate

our students into the Navy. Do you see my point? I am perfectly willing that the bill should be passed; I am perfectly willing to have my graduates get the benefit of it; and I am perfectly willing to accept the benefits which will come to our college, but I do not think it wise at this time to make any effort for the passage of the bill.

Mr. ALVORD. This Association divides itself into sections and comes together in general session to confirm or disapprove the action of these sections. If we assign to the section on horticulture, for instance, the consideration of matters pertaining to that subject, would we not naturally suppose when the section came here with a recommendation that it had carefully discussed the subject? Would we not, except in an extreme case, heartily approve its recommendations and aid it in carrying on its work by the loan of the name of the Association?

Now, when the college section presents matters with the request that the Association indorse them, should that not be done? Should not this request, which refers to a matter of importance to the colleges only, be treated in a liberal spirit? It does not ask much. It simply requests the appointment of a committee of three to act in the name of the Association in furthering a measure which seems to that section to be of great importance to the colleges. We can do this as well as we can authorize a special committee on horticulture to act in the name of the Association. It would seem to be quite as good a thing to do as to appoint a committee to attempt to control the manufacture of nozzles for spraying-pumps. I think we shall be safe in trusting the three college presidents whom it is proposed to appoint, to do what is best for the Association. I think an important precedent is now to be established, that is, that when a matter has been thoroughly digested by a section and a conclusion reached, the convention as a whole should abide by that action.

Mr. HADLEY. Allow one remark. It is quite proper for the sections and committees to discuss matters fully and to agree upon conclusions; it is just that their reports should be treated with great respect when reported; but it seems to me very important that this Association should reserve to itself full right to act upon these matters when brought before it as to it may seem best. [Applause.]

The PRESIDENT. The question is upon the passage of the resolution presented by the college section.

A vote was taken, and the Chair announced that the ayes seemed to be in a majority. A division was called for. The count showed 32 votes for and 17 against, and the resolution was declared adopted.

Mr. Atherton further reported from the committee to which was referred an invitation to take part in a congress of agricultural organizations, as follows:

(1) The committee to which was referred the invitation to this Association to take part in the formation of an American association of agricultural organizations, having given the subject the careful consideration which its importance justifies,

respectfully recommends the adoption of the following statements, to be sent as a reply to the invitation:

In view of the fact that the colleges and experiment stations represented in this Association are organized under the concurrent action of the United States and the several States, and that their duties, obligations, and sphere of action are defined by specific laws, and that they are severally subject to the control of boards of trustees, to whom they are responsible, and by whom alone the organic relations of each institution to other bodies can be determined, it does not appear to the Association that it could properly, or with advantage to either party, join in an association with other bodies differently organized and not subject to similar legal control. Nevertheless, in order to manifest a cordial good will towards a movement designed to occupy a portion of the same great field and, in order to prepare the way for such coöperation as may hereafter seem practicable, consulting delegates will be appointed, with authority to represent this Association in the proposed convention or conference, and to report to the next annual convention.

(2) Your committee also recommends the adoption of the following resolution:

Resolved, That the president and the chairman of the executive committee of the Association, with two additional members, to be appointed by the Chair, be and hereby are appointed consulting delegates, with authority to attend (if circumstances seem to render it advisable) the proposed convention or conference; but such delegates shall have no authority to commit this Association to any definite line of action or policy, but shall report to the next annual convention.

The resolution was adopted.

Mr. Armsby reported for the committee appointed to consider the advisability of a coöperative station exhibit at the World's Columbian Exposition, as follows:

Resolved, That in the opinion of this Association it is advisable to have a coöperative station exhibit at the World's Columbian Exposition.

Resolved, That in order to formulate and carry out such preliminary steps as are necessary during the year, a special committee, with power to represent the Association, be appointed by this convention to coöperate with the U. S. Department of Agriculture, and to take such other action as may be necessary.

Resolved, That the executive committee be authorized to pay from the funds of the Association the actual and necessary expenses incurred by the special committee above provided for, in the discharge of its duties.

On motion of Mr. Turner, the resolutions were adopted.

On motion of Mr. Alvord, it was ordered that a committee of five station directors be appointed by the Chair to carry out the plan proposed in the resolutions just adopted.

The President appointed Messrs. Armsby, Thorne, Morrow, Tracy, and Henry.

The committee on nominations, through its chairman, Mr. Fairchild, of Kansas, presented the following nominations for the ensuing year:

For president, H. H. Goodell, of Massachusetts.

For vice-presidents, O. Clute, of Michigan; A. Q. Holladay, of North Carolina; J. W. Sanborn, of Utah; I. P. Roberts, of New York; E. D. Porter, of Missouri.

For secretary and treasurer, M. A. Scovell, of Kentucky.

For executive committee, H. E. Alvord, of Maryland; J. H. Smart, of

Indiana; M. C. Fernald, of Maine; J. A. Myers, of West Virginia; W. M. Hays, of Minnesota.

On motion of Mr. Peabody the report was adopted, and the Secretary was directed to cast a ballot for the persons named in the report. The Secretary reported that the ballot had been cast and the President declared the officers duly elected.

Mr. Alvord offered the following resolution, which was adopted:

Resolved, That the publication of the proceedings of this convention, including the President's address in full, be referred to the executive committee in coöperation with the Department of Agriculture, with the recommendation for expeditious action and full authority to edit the same.

Mr. Redding offered the following resolution:

Resolved, That in the preparation of the printed program for the next annual convention of this Association, the executive committee be requested to state in brief, as far as practicable, the leading propositions that will be affirmed and maintained by the essayists or speakers, and that copies of such programs so prepared be sent to each delegate now in attendance, and to each college and station at as early a day as practicable before the next annual meeting.

He said he believed that he would receive much more benefit from the convention if he had beforehand more definite knowledge of what was to be discussed than could be derived from mere titles of papers; and, further, although the president and secretary of the agricultural committee duly made and prepared a program for the meeting, he had himself been unable to obtain a copy of it; neither had he seen a copy of the general program of the convention until he reached Champaign.

Mr. ARMSBY. The secretary would like to make a statement in regard to this matter. As all know, a notice of the convention was sent out, as required by the constitution, three months before the time set. At the same time correspondence was begun with members of the Association, earnestly requesting them to send in topics for discussion in the general and section meetings. They were urged to act as promptly as possible, as it was desired to prepare the program in good time. But it was found impossible to obtain programs from the chairmen of the sections in time to publish them earlier than was done. The programs were sent out about the 21st of October. I leave it to the convention to judge when the program could have been distributed had the chairmen been obliged, in addition to what they did, to prepare analyses of each paper to be presented. I desire to state that as soon as the programs were printed a copy of the general program and one of the committee programs, with an accompanying circular, were promptly mailed to each college president and each station director. It was, perhaps, an omission on the Secretary's part that he did not send programs to each station worker, but it was supposed that the presidents and directors would bring the matter to the attention of their subordinates.

Mr. SCOTT. I would like to suggest that hereafter a sufficient number of programs be sent to presidents and directors to supply their subordinates.

The resolution offered by Mr. Redding was referred to the executive committee for its consideration.

Mr. Clute offered the following resolution, which was adopted:

Resolved, That this Association hereby acknowledges the efficient services of its executive committee during the past year, and especially of its chairman, President Alvord, and that most hearty thanks are hereby extended to the committee and to its chairman.

Mr. Patrick having called for a resolution of his which had been referred to the committee on the order of business, Mr. Alvord, for that committee, presented it as follows, with recommendation for adoption:

Resolved, That the executive committee be requested to so frame the program as to allow more time for the meeting of the various sections.

The resolution was adopted.

Mr. ALVORD, for the same committee, recommended the adoption of the resolutions offered by Mr. Fernald (see p. 64).

Mr. Porter moved to amend the resolutions by the addition of the following:

Resolved, That the executive committee is hereby instructed to cause a copy of these resolutions to be engrossed and forwarded to the Hon. Justin S. Morrill.

The amendment was carried and the resolutions as amended were adopted.

Mr. Alvord then offered the following:

Resolved, That the secretary of this Association for the coming year be directed to invite Sir John B. Lawes to cause the first course of lectures on the Rothamsted experiments to be delivered before this Association at its next meeting. In case the invitation is accepted, the executive committee is instructed to notify the members of the fact, and to announce in the call for the next meeting the particular time in the course of the sessions when these lectures are to be delivered.

The resolution was unanimously adopted.

Mr. Alvord then offered the following:

Resolved, That the thanks of the Association are due and are hereby heartily tendered to the Regent, the faculty and students of the University of Illinois, and the citizens of Champaign and Urbana, for the welcome accorded to those attending this convention and the many courtesies by them received.

The resolution was unanimously adopted.

The Chair then called upon Mr. Atwater, Director of the Office of Experiment Stations of the U. S. Department of Agriculture, who desired to present some matters of importance to the convention. Mr. Atwater said:

Mr. CHAIRMAN AND GENTLEMEN, I wish to speak to you about indexes to station and other literature about the publications of the Office of Experiment Stations; about compilations and investigations; and to make a few brief references to coöperative experiments.

In relation to indexes, I have with me a package of index cards such as we are making at the Office of Experiment Stations. Those of you who have noticed the last number of the first volume of the Experiment Station Record will remember that there are 32 pages of fine-print,

double column index. This is, in fact, an index to the station publications for the year described in the volume, but that index alone will not suffice. After considering the various ways of making indexes we, like many others, have come to the conclusion that the best method is by the use of cards. I have here the outline of a system of indexes, but I have not time to read it in full. In brief, our card index will contain a short abstract of the subject matter, as well as the reference. This card index we propose to make cover all the station publications. Copies of this card index we would like to place at the disposal of each college and station.

We do not feel however that we can print them——

The PRESIDENT. We think you ought to do it.

Mr. ALVORD. We believe that is what your Office is made for and what your appropriations were given for.

Mr. ATWATER. For the printing of these cards?

Mr. ALVORD. Yes, to furnish us forms, information, and advice. We will get you money to do that if necessary.

Mr. ATWATER. Give us the money and we will do it. What we want is to have these cards printed and in your hands.

Noticing the lateness of the hour, Mr. Atwater, after mere mention of the other matters of which he desired to speak, resumed his seat.

It was suggested that a special meeting of station directors should be called at some convenient time and place to consult with Mr. Atwater.

The Chair announced as the consulting delegates to attend the pending convention of agricultural organizations, the incoming president of the Association, the chairman of the executive committee, and Mr. Neale and Mr. Atherton.

Mr. Atherton then stated that the article in the constitution on membership, which reads "At any regularly called meeting of the Association, each college established under act of Congress approved July 2, 1862, and each experiment station established under State or Congressional authority, and the Department of Agriculture shall be entitled to one vote," etc., was drafted before the Office of Experiment Stations was created, and that whereas that Office has come to be an important connecting link between the Association and the Department, he wished, without any suggestion, direct or indirect, from any source whatever, to move that the constitution be amended so as to admit the Office of Experiment Stations, as such, and in addition to the U. S. Department of Agriculture as a whole, to membership in this Association.

The amendment was unanimously adopted.

Mr. Hadley offered the following resolution, which was adopted:

Resolved, That each experiment station be requested to attach to each bulletin such titles and analyses as would be suitable for use in cataloguing the said bulletin.

Mr. Alvord stated that in his opinion the time had come when the Association should proceed with more care in making amendments to the constitution, and gave notice that at the next convention he would

move to amend the constitution so as to require previous published notice of an intention to offer amendments.

Mr. Neilson offered the following resolutions:

Resolved, That the executive committee be authorized to call at Washington during the coming winter a meeting of station directors for consultation with the director of the Office of Experiment Stations, if that be found practicable.

Resolved, That the preparation and publication of indexes of station publications by the Office of Experiment Stations is hereby recommended, and that the consideration of means necessary to enable that Office to do its work and also to serve as the medium of communication between station workers, be referred to the executive committee for consideration.

Resolved, That Congress be asked for sufficient means to defray the cost of the work above mentioned and to extend the work of the Office so as to enable it to enter into the compilation of the results of investigations by European stations.

Mr. Armsby said that he was heartily in favor of the first resolution and thought it highly desirable that a consultation of directors with the Office of Experiment Stations should be held, and inquired whether it had not been clearly shown at this convention as well as previous ones, that a section of directors should be organized for the special purpose of discussing such questions.

Mr. Jenkins suggested that the directors might profitably hold a meeting at the close of the convention for the discussion of such matters. The Chair suggested that the directors might have conference with the Director of the Office of Experiment Stations immediately upon the adjournment of the session of the convention.

The resolutions were adopted by separate votes.

The following resolution offered by Mr. Scovell was unanimously adopted:

Resolved, That the thanks of this convention are hereby tendered to the retiring President and Secretary for the efficient manner in which they have discharged their respective duties in this convention.

The President then spoke as follows:

I wish to thank the members of this convention for the kindness of this resolution, and to express my appreciation of the honor they conferred upon me in electing me president of this Association, and of the consideration they have extended to me in the performance of my duties. I extend my congratulations to the convention for the success with which the business of the meeting has been dispatched, and now declare the convention adjourned without day.

APPENDIX.

MINUTES OF THE PERMANENT COMMITTEES OR SECTIONS.

THE PERMANENT COMMITTEE ON AGRICULTURE.

Morning Session, Thursday, November 13, 1890.

The meeting was called to order at 9 a. m., Mr. Sanborn in the chair. Mr. Thorne read the following paper:

Pot or Box vs. Plat Experimentation, C. E. Thorne.

The subject announced for discussion is, "Pot or box *vs.* plat experimentation," but in discussing it I shall take the ground that when properly employed, there is no possible antagonism between the two methods, but each may be made to supplement the other.

The farmer deals not with pots and boxes, but with fields, and we must meet him in the field and there demonstrate by methods which he employs or can employ, the superiority of one process over another. If we can not do this we may as well admit that the idea of improving agriculture by means of the experiment station is a fallacy.

In my judgment, therefore, we have no choice as to whether we shall or shall not employ plat or field experimentation as one of our methods of research. We must employ this method, and therefore it behooves us to bend our energies toward perfecting the method and not to waste our time in railing at its numerous defects nor in searching for some easier method to take its place.

Let us remember that field experimentation is still in its infancy. A dozen years ago, when I began to study the soil through field experiments, there were scarcely half a dozen other men in the nation similarly engaged. Since that time I have had several years' personal experience in the work, during which my failures have largely outnumbered my successes. I have not been unobservant of the work of others; but I am to-day more firmly fixed than when I began, in the faith that it is possible to achieve trustworthy results through this method, and in the conviction that all our work with plants and soils must be subjected to this method as a final test before it can be accepted as a reliable guide.

The chief criticism made upon this method is the difficulty of securing sufficient areas of soil that are absolutely uniform in composition, drainage, and exposure. I fully recognize this difficulty. It is a much more serious affair to select a piece of land that is suitable for a field experiment than would be suspected by one who has never made such an experiment, and I am fully persuaded that a very large proportion of the field experiments that have been reported from time to time are utterly worthless if not actually misleading. But I am equally confident that it is both possible and practicable by judicious selection, drainage, and tillage, to so fit a plat of ground for comparative plat experiments that results may be obtained from it which will bear comparison with the best laboratory work.

I do not expect that it will ever be possible to secure precisely identical results from duplicate plats; this is not possible in the laboratory. I do not expect that it will be possible to reduce the margin of error to so low a point in the comparison of duplicate plats as it is in the laboratory analysis of duplicate samples of milk, for instance; but I do believe that this margin may be reduced quite as low in field tests as it is now possible to reduce it in soil analysis.

As a reason for the faith that is in me I offer the results of an experiment made at our station this season in the continuous culture of wheat on the same soil, without manure, and with various combinations of fertilizers. The plat of land selected for this work contains 24 plats of one tenth acre each, numbered from east to west. A grove of timber stands not far east of the plat, and a single tree stands nearer still.

The two crops grown on this plat give evidence that the plats fr m 19 to 24 inclusive, are lower in fertility than the remaining ones. As a whole, however, the plat is one of apparent uniformity in soil, exposure, and natural drainage. It slopes slightly to the north; the soil is a clay, lying upon the bowlder clay of the drift, and this in turn upon the Huron shales, the rock being probably between 12 and 20 feet from the surface. Originally the field was covered with timber, chiefly beech and elm, and the soil was water-soaked for a considerable portion of the year.

In preparing the field for this experiment it was first drained by three-inch tiles, laid 3 feet deep and 36 feet apart. It was then divided into plats 16 feet wide by 272½ feet long, the plats being separated by alley-ways 2 feet wide. As the alternate alley-ways were located over the drains each plat has a drain running its entire length on one side or the other.

The field was in clover in the spring of 1888. The draining was done that spring, and during the summer the plat devoted to this experiment was plowed flat. The first harvest yielded at the rate of 43 bushels per acre for the unfertilized plats and no more for those fertilized. However, there were considerable irregularities in the yield, due partly to the fact that the drains had been filled by the plow, thus leaving dead furrows in the edges of the plats.

In preparing for the crop of this year the plats were plowed separately so as to give a furrow for surface drainage between them. The surface was also carefully planed so that no basins should be left to hold water during the winter, and great care was exercised in seeding, distributing the fertilizers, and harvesting and threshing the grain. The results attained are as follows:

Plat No.	Fertilizer.	Yield per acre.	Increase from fertilizer.
		Bushels.	*Bushels.*
1	Unfertilized	31.9	....
2	Superphosphate	35.6	3.7
3	Potash	32.1	0.3
4	Unfertilized	31.8	....
5	Nitrate of soda	36.5	4.3
6	Nitrate and superphosphate	38.6	6.0
7	Unfertilized	33.0	....
8	Superphosphate and potash	36.4	3.6
9	Nitrate and potash	36.8	4.2
10	Unfertilized	32.4	....
11	Superphosphate, potash, and nitrate, 16	36.9	5.6
12	Superphosphate, potash, and nitrate, 32	35.7	5.6
13	Unfertilized	29.9	....
14	Superphosphate, potash, and nitrate, 48	34.9	4.8
15	Superphosphate, potash, and ammonia	33.8	2.5
16	Unfertilized	32.4	....
17	Nitrate, potash, and rock phosphate	37.4	5.5
18	Nitrate, potash, and slag phosphate	37.3	5.8
19	Unfertilized	31.0	....
20	Barn-yard manure	34.7	5.2
21	Linseed-oil meal	33.9	5.9
22	Unfertilized	26.5	....

In calculating the increase on the various fertilized plats, it is assumed that the changes in fertility are uniform from one unfertilized plat to the next. Calculated in this way the increase for phosphoric acid on plat 2 is 3.7 bushels, and for phosphoric acid and potash on plat 8 is 3.6 bushels; that for nitrogen on plat 5 is 4.3 bushels, and for nitrogen and potash on plat 9 is 4.2 bushels. Potash apparently has had practically no effect when used alone on plat 3, or in conjunction with phosphoric acid on plat 8, or with nitrogen on plat 9. Neither has it added to the increase when used in conjunction with both phosphoric acid and nitrogen, as seen by comparing plats 11, 12, 14, 17 and 18 with plat 6.

Taking the plats receiving both phosphoric acid and nitrogen, that is, Nos. 6, 11, 12, 14, 17 and 18, the uniformity in the increase is very striking; so close is it as to warrant the suspicion that the figures have been doctored. The fact is, however, that the weights of grain in column 1 are the actual weights as taken from the field, without any change or correction whatever. Plat 14 shows a smaller increase than any of the other plats receiving nitrate of soda and superphosphate, and this was expected before the wheat was harvested, as the grain on this plat lodged early in the season and remained down. In fact the results in every case are in perfect harmony with the appearance of the plats before harvest. The effect of the fertilizers began to be apparent early in the season, and became more and more conspicuous as the season advanced, up to the time of heading out. After that period the unfertilized plats appeared to make greater progress than those that had received the fertilizers, but in every case the difference between the fertilized and unfertilized plats was apparent, while throughout the season it was impossible to distinguish any difference between plats 3 and 4, 8 and 9, or 17 and 18. In short, the coincidences in this experiment are too many and too uniform, and were too evident throughout the growth of the crop to be mere coincidences.

Allow me here to call attention to the method of computation employed in calculating the results of this experiment. As I have said, I have assumed that the changes in natural fertility from plat to plat were uniform; that is, that if plat A yields 30 bushels and plat D 33 bushels, both being unfertilized, the probability is that plat B would have yielded 31 bushels and plat C 32 bushels without fertilizing. Suppose, however, we had left but two unfertilized plats in this experiment, and those had happened to be numbers 7 and 16, and then that we had taken the average yield of these plats as that of the entire plat under experiment; our apparent increase from the fertilizers would then have been as shown in the third column of the following table, the increase actually found being repeated in the second column for comparison:

Plat No.	Increase as found.	Increase over plats 7 and 16.	Increase over average unfertilized.
2	3.7	2.9	4.5
3	0.3	....	1.0
5	4.3	3.8	5.4
6	6.0	5.9	7.5
8	3.6	3.7	5.3
9	4.2	4.1	5.7
11	5.6	4.2	5.8
12	5.6	3.0	4.6
14	4.8	2.2	3.8
15	2.5	1.1	2.7
17	5.5	4.7	6.3
18	5.8	4.6	6.2
20	5.2	1.8	3.4
21	5.9	1.2	2.8

Comparing the duplicate fertilized plats, disregarding potash, and omitting No. 14, for the reasons already given, we have the following results:

Fertilizer.	Plat No.	Increase as found.	Increase over plats 7 and 16.	Increase over average unfertilized.
Superphosphate	2	3.7	2.9	4.5
	8	3.6	3.7	5.3
Nitrate	5	4.3	3.8	5.4
	9	4.2	4.1	5.7
Superphosphate and nitrate	6	6.0	5.9	7.5
	11	5.6	4.2	5.8
	12	5.6	3.0	4.6
	17	5.5	4.7	6.3
	18	5.8	4.6	6.2

In the one case the extreme variation in the rate of increase on duplicate plats is but half a bushel, or 9 per cent of the lowest rate, whereas in the other it is nearly 3 bushels, or 97 per cent. In other words, the margin of error according to the first calculation, is about 1½ per cent of the average total yield of the fertilized plats under comparison, whereas in the other case it is nearly 8 per cent.

If we had taken the average of the eight unfertilized plats as the basis of computation the case would have been scarcely any better, as shown by the last column of the tables. Moreover, either of these methods would have been totally misleading with respect to the relative yield of the barn-yard manure and linseed-oil-meal plats numbers 20 and 21, owing to the decided decrease in natural fertility of that end of the plat.

Averages are very convenient to the hasty computer, and averages must settle many questions for the most careful investigator, but it is plainly possible to draw wholly erroneous conclusions from an average.

In the same field with the plat devoted to the experiment just described, and lying contiguous to it, are two plats devoted to simliar experiments with corn and oats. There is this difference, however, between the soil of the wheat plat and that of the corn and oats plats, and that is, that while the surface of the three is quite uniform in appearance, digging reveals the fact that the corn and oats plats are located upon a gravel subsoil, lying from 2 to 5 feet or more below the surface. This gravel subsoil gives sufficient natural drainage for ordinary farm cropping, but in the hope of securing greater uniformity of drainage tiles were laid through these plats on the same plan as through the wheat plat. The desired end seems not to have been accomplished, however. We do not get the uniform results from this work that we do from the wheat, although further cropping may obliterate some of the inequalities that are now perplexing us.

But anyone who is familiar with the method in which sand and gravel are stratified in kames and moraines will realize that it is not probable that the soil resulting from such formations should be so uniform in quality as that from the weathering of a material like the bowlder clay of the Ohio drift or of limestone or sandstone rocks. The layers of sand will weather much more rapidly and form a soil of much greater depth than those consisting chiefly of coarse gravel.

In the case of deep beds of sand, the weathering may penetrate to such a depth as to impede drainage, whereas in that of coarse gravel the soil may be so shallow as to leach too rapidly. A large proportion of the field experiments made at the Ohio Station have been made upon soil of this character, and the more I work upon it and study it the more fully I am convinced that it is not the best soil for comparative tests.

POT AND BOX EXPERIMENTS.

I suppose that Dr. Paul Wagner, director of the Darmstadt Experiment Station, has made a greater number of pot or box experiments than any other man, and that he may with propriety be styled the leading advocate of this method of research. I regret that I am not able to quote directly from Dr. Wagner, but I probably do him no injustice in quoting from a report of his work published in No. 81 of United States Consular Reports. His position is there stated to be that "it is difficult to find parcels of ground like one another all in all; the measuring and dividing them off, the working, manuring, sowing, and harvesting, as well as the fixing of the weights of the products realized can not be the same in each instance."

All of this is quite true; but the question arises, Is the pot method wholly free from similar sources of error? and is it not probable that the errors of this method, insignificant though they may appear as they stand, may yet grow to proportions quite as great as those in well-conducted field experiments, when multiplied by the factors required to bring them into comparison with field work? But this multiplication must be made; the farmer deals with bushels and acres and our results must be stated in bushels and acres before they can be of any value to him.

In order to throw some light on this question I have calculated the percentage variation between the yields of neighboring unfertilized plats in the fertilizer experiment previously referred to, and also between those of certain synonymous plats of wheat in our variety test of this year, reported in our July bulletin. In this case, the seed had been derived from different sources, and some variation in product would be expected on this account. These lots were purposely sown on adjoining or neighboring plats for comparison. The soil is river bottom, underlaid with gravel at a depth of about 5 feet.

For comparison with this work I have calculated the variation in forty-five triplicate pot tests, as reported by Dr. Wagner, and thirty-five similar tests reported in Bulletins 6 and 8 of the Imperial College of Agriculture and Dendrology of Japan, by Dr. O. Kellner, who has closely followed Dr. Wagner's method. The variations are calculated in percentages of the lowest yields, and the results are shown in the accompanying tables:

Variations between duplicate plats.

OHIO STATION, 1889.

Fertilizer tests.		
Plat No.	Wheat. Product.	Wheat. Variation.
	Bushels.	*Per cent.*
1	31.9	
		0.3
4	31.8	
		3.8
7	33.0	
		1.9
10	32.4	
		8.4
13	29.9	
		8.4
16	32.4	
		4.5
19	31.0	
		17.0
22	26.5	

Variety tests.		
Plat No.	Wheat. Product.	Wheat. Variation.
	Bushels.	*Per cent.*
5	29.33	
		2.8
6	28.53	
		2.7
7	29.29	
11	36.16	
		0.0
12	36.16	
16	32.50	
		4.5
18	31.08	
		3.4
20	30.06	
24	27.50	
		9.1
27	30.00	
		7.0
28	32.16	
		3.6
29	31.04	
39	36.00	
		5.3
40	34.20	
51	29.58	
		1.6
52	29.12	

General average variation, 5.0.

Variations between triplicate pots.

DARMSTADT STATION, 1886.

Barley.		Wheat.		Flax.	
Product.	Variation.	Product.	Variation.	Product.	Variation.
Grams.	*Per cent.*	*Grams.*	*Per cent.*	*Grams.*	*Per cent.*
11.01		6.90		18.63	
11.31	5.5	6.12	14.7	19.35	
11.50		6.11		21.04	16.6
11.62		7.01		19.63	
23.87		19.31		21.73	
24.45	6.0	18.78	9.0	59.36	
25.30		20.47		55.61	6.8
28.06		26.76		57.14	
30.04	7.0	25.25	6.0	67.52	
29.33		25.42		66.73	5.8
20.12		14.04		70.62	
20.41	2.9	13.64	5.7	43.26	
19.83		14.43		41.76	12.4
21.61		18.80		46.79	
23.12	7.0	17.13	9.7	53.96	
22.97		17.57		55.14	2.5
15.83		10.53		53.79	
14.93	7.3	9.13	15.3	30.44	
14.75		9.36		33.38	9.6
17.51		12.49		30.83	
16.72	4.8	10.82	15.4	34.15	
17.36		12.27		36.18	5.9
14.83		9.94		35.20	
15.06	3.3	10.08	5.2	29.03	
14.58		9.58		29.78	7.2
15.47		12.49		31.11	
16.01	3.9	11.06	20.7	35.12	
15.41		10.35		35.12	5.3
28.10		21.09		36.98	
29.20	3.9	24.00	13.8	65.33	
28.30		22.25		61.53	6.3
29.54		25.55		61.46	
30.03	4.6	26.14	2.3	68.26	
28.70		25.80		70.13	3.2
26.21		23.06		70.46	
28.00	6.8	21.09	6.4	59.72	
26.20		23.45		60.84	7.2
29.02		24.92		64.00	
30.41	4.8	25.95	4.1	71.68	
29.10		25.22		72.61	2.9
17.80		12.92		70.53	
18.10	1.2	13.00	8.6	44.14	
18.02		11.97		44.73	2.2
21.41		17.51		43.75	
20.20	6.0	16.21	8.9	52.22	
21.02		16.07		52.17	1.5
				52.99	
Av. variation...	5.0	....	9.7	....	6.3

JAPAN STATION, 1888–89.

Barley.		Paddy.		Rice.	
Product.	Variation.	Product.	Variation.	Product.	Variation.
Grams.	*Per cent.*	*Grams.*	*Per cent.*	*Grams.*	*Per cent.*
140		112.0		633.9	
171	22.1	136.5		594.4	6.6
145		124.4	38.3	599.5	
208		105.4		688.4	
197	7.2	84.1		682.5	7.1
194		113.8		622.3	
244		95.5		669.3	
224	12.4	92.7	8.3	695.1	3.9
217		100.4		678.8	
242		375.6		688.8	
206	17.4	392.2	4.4	678.3	33.2
206		380.0		517.1	

Variations between triplicate pots—Continued.

JAPAN STATION, 1888-89—Continued.

Barley.		Paddy.		Rice.	
Product.	Variation.	Product.	Variation.	Product.	Variation.
Grams.	*Per cent.*	*Grams.*	*Per cent.*	*Grams.*	*Per cent.*
307 302 240	27.9	592.2 564.7 606.6	7.4	717.1 643.1 564.5	27.0
164 164 162	1.2	467.0 509.0 521.7	9.0	695.5 680.3 640.7	8.5
245 211 208	17.9	495.6 553.9 624.7	26.5	697.3 686.2 679.0	2.7
252 227 186	35.4	514 2 620.9 638.4	24.1	604.7 638.7 703.2	11.4
335 315 280	19.7	596.4 575.4 626.1	8.8	693.5 590.1 643.2	17.5
530 435 398	33.2	590.2 580.1 646.4	11.4	359.0 390.3 379.5	8.7
		578.8 609.2 651.3	12.5	449.0 521.8 481.9	16.1
		289.8 328.4 269.7	21.8	484.4 436.2 435.2	11.4
		497 5 531.7 496.4	7.1	448.2 455.9 453.1	1.7
Av. variation...	19.4	....	14.9	....	13.4

These tables demonstrate the possibility of obtaining in the field results quite as consistent as those given by the best pot work; but in considering the table we should remember that in field work we expect some natural variation in the soil, whereas pot experiments are supposed to begin with a soil made absolutely uniform. When this is considered I think we must admit that unless pot culture can show very much more uniform results than those of the experiments referred to, we must assign the method to a secondary place, as compared with field experiments, in the study of the problem of the maintenance of soil fertility.

I would not be understood, however, as denying the utility of pot experiments. It may often be practicable to make such tests where field tests are impossible. In such case they may serve an excellent purpose, and as they are far more easily made than field tests and admit of indefinite duplication on small areas, they may often be usefully employed in preliminary surveys of lines of work, afterward to be followed by more accurate tests in the field. For such purposes there is an important place for pot experiments. We are employing them constantly in our work, as supplementary to our field work, and hope to largely extend their use.

Mr. Armsby said that all present who had anything to do with field tests would certainly feel encouraged by the results reported in the foregoing paper; their close agreement was very gratifying. Upon the question between pot and field experiments, however, there was something more to be said regarding the purposes of the two, which, according to his understanding, covered different grounds. Advocates of pot experiments claimed that by that method they could control all or very nearly all of the conditions, for example, the water supply, texture

and depth of soil, position of the water-table in the soil, etc., to a far greater extent than was possible in the best-conducted field experiments, and were therefore able to experiment upon more strictly scientific principles, making all the conditions to conform save the one whose influence was to be tested. Pot experiments could be used in investigating scientific principles, such as the relative value of different forms of phosphoric acids, and the feeding capacities of different classes of plants, whereas such investigations he believed were impossible by field tests. In his judgment the pot experiment was designed as a means of investigation into scientific principles of plant nutrition, while the purpose of the field experiment was to test the application of the pot experiment. What was wanted was a field test as accurate as possible, conducted in some such way as had been described, not to test the correctness of the conclusions from the pot experiments, but their applicability to field conditions, some of which might tend to modify results. This seemed to be the essential distinction between the two classes of experiments.

Mr. Atwater wished to add a word in confirmation of points made in Mr. Thorne's paper. Those familiar with the experiments made by Sir John Bennet Lawes would remember how he commenced. One of his earlier ideas was to make a field experiment which should be uniform, and he selected a large portion of land and put in men with shovels and wheelbarrows to dig out and wheel away the soil, mixing it as he would if taking samples for analysis. The area thus dug out was then divided by brick walls lined with cement, into individual plats, each half a meter or a meter square, in which the carefully mixed earth was carefully replaced, the subsoil beneath and the surface soil on top, and stamped down as uniformly as possible. The labor of days and weeks being given to secure a number of uniform plats. It would seem that uniform results could be obtained from these plats, but as a matter of fact there were very wide variations, the reason for which became apparent: They were due to differences in moisture underneath. Another modifying factor in field experiments, and one which often caused considerable variation in results on plats in close juxtaposition, was difference in arrangement of the soil strata, the layers frequently varying widely within a short space. It was hopeless to expect uniformity of results unless uniformity of moisture was first made sure.

Mr. Thorne's method seemed to afford a crucial experiment for field tests. Some years ago he had followed that plan in a large number of experiments, and in making extended calculations based upon these experiments he had been astonished to find that while in certain experiments the effect of nitrogen, phosphoric acid, or potash was thoroughly uniform, in others a large minus was shown for nitrogen on one plat and on another plat a large plus. Again, with corn, taking 200 experiments, he had first cast out 120, and then weeded out half of the remaining 80, leaving only 40 that stood the test. He had supposed

that these could be relied upon for generalizations, but oddly enough, when the average results of the 40 were compared with the average of all, the conclusions from both sets were found to be very nearly the same. When a great number of such experiments were calculated upon, the "might of average figures" would be realized.

On motion, the committee proceeded to the election of officers for the ensuing year. The following-named gentlemen were nominated and elected:

Chairman, Charles S. Plumb, of Indiana.

Vice-chairman, G. E. Morrow, of Illinois.

Secretary, C. E. Thorne, of Ohio.

Mr. Armsby read the following paper:

Is a Digestion Experiment Fallacious? H. P. Armsby.

Webster says: "A fallacy is an argument which professes to be decisive, but in reality is not."

It is to be observed, then, that the question under discussion is not that of the accuracy of a digestion experiment, but of the correctness of the logic upon which its conclusions are based. As regards this we have to ask:

1. What is the conclusion reached?
2. What is the reasoning by which it is reached?
3. Is that reasoning false?

1. The conclusion is that a certain percentage of each of certain groups of proximate constituents has been extracted from a certain fodder or ration by the digestive apparatus of the animal experimented on.

2. The reasoning has as its data the facts, (*a*) that a certain amount of these ingredients was eaten by the animal during a series of days; (*b*) that a certain amount of each of them was found in the solid excreta voided during the same time.

Starting from these data, the argument assumes as its premises:

(1) That matter is indestructible.

(2) That on the average of a sufficiently long time as much of any substance leaves the alimentary canal as enters it, or in other words, that the capacity of the latter is limited.

(3) That matter can escape from the alimentary canal only by digestion and resorption or in the dung.

The reasoning may be represented algebraically thus: Let A equal the amount which enters alimentary canal, B the amount which leaves alimentary canal, C the amount excreted in dung, D the amount digested.

From (1) and (2) we have $A=B$, from (1) and (3) we have $C+D=B$. Equating the two values of B we have $A=C+D$, $D=A-C$.

That is, the amount of any substance digested equals the amount entering the alimentary canal minus the amount found in the dung.

3. Is this reasoning correct? I am not a logician, but so far as I can see, the reasoning in the form given above is strictly correct. In an ordinary digestion experiment, however, we silently introduce another premise, namely, that nothing enters the alimentary canal except through the mouth, and say that food minus dung equals food digested. This assumption, however, has been proven to be false, and therefore, strictly speaking, the ordinary digestion experiment involves a fallacy. Practically, however, this is rather to be classed with the errors of experiment than as a logical fallacy. Its existence has been well known for years, although its importance was long underestimated, and we are even now able to make some approximate estimate of its amount.

My answer to the question proposed, then, is briefly, that a digestion experiment

conducted according to the best methods we now possess, while not so accurate as might be desired, is not in any fair construction fallacious.

It occurs to me as just possible, however, that what the Chairman had in mind in propounding this question was not so much the digestion experiment itself as the conclusions sometimes drawn from it as to the nutritive value of the feeding stuffs in question.

It hardly seems necessary to remark before this audience that a digestion experiment, *per se*, gives us no *direct* information as to the nutritive value of the substances experimented on. The question whether the amount of digestible nutrients in a fodder, as determined by a digestion experiment, is a measure of its nutritive value, is an entirely distinct question, to be settled by an entirely different kind of experiment, namely, by comparing the amounts of digestible matter consumed in different cases and in different fodders with the actual nutritive effect produced. Now, while there is no serious difficulty in determining with reasonable accuracy the amounts of digestible matter fed, any one who has had any considerable experience in conducting feeding experiments knows it is by no means an easy matter to satisfy himself that he he has reached even an approximation to the true nutritive effect. If he makes any critical study of his results, he will, I am sure, appreciate the statement made by a student in a recent examination paper, that "A feeding experiment may be more or less accurate."

Who can tell what the live weight of his animals is, either at the beginning of his experiment or at the close? How much of the apparent gain or loss of weight is really solid matter and how much is due to changes in the percentage of water in the tissues? How much of the real gain or loss of solid matter is flesh? How much fat? How much ash? In how many feeding experiments can these questions or any one of them be answered? And yet without an answer to them the true nutritive effect remains uncertain.

I am not disparaging such feeding experiments as have been made by the majority of experiment stations, both in this country and Europe. For the practical ends which they have been designed to serve, the effect of the feeding can be determined with sufficient accuracy, and a vast deal of most valuable information has been afforded by these experiments. The question now under consideration, however, is of a different character, involving an exact scientific comparison of food with nutritive effect and requiring an exact control of all the conditions of experiment. I hold, therefore, that it is only by considering the results of large numbers of such experiments that we can get any trustworthy information on this point, and that even then we reach only a greater or less degree of probability. Even a considerable number of results apparently opposed to the view that the digestible matter of a fodder measures its nutritive value, I do not regard as decisive.

It would require vastly more time than I have had at my disposal, to investigate exhaustively the evidence bearing on this question, and the results would constitute a monograph for study rather than a paper for such a meeting as this. I may be allowed, however, to express my personal opinion that the balance of probability is steadily increasing in favor of the view that a determination of the digestibility of a fodder gives us a fairly accurate measure of its *potential* nutritive effect. Whether this potential effect is made actual in any given case depends very largely upon the skill and knowledge of the feeder. This conclusion, of course, does not exclude the possibility of finding a better measure of the nutritive effect or of greatly perfecting this one. Indeed I believe very strongly that our stations would in the end strengthen themselves by doing a fair share of strictly scientific work upon such problems as this, not only in connection with stock feeding, but with all branches of their work.

Mr. Curtis (in the chair) said that he, for one, desired to express his appreciation of the views presented in the paper just read; he

presumed that most of those present would acknowledge an inability to discuss the matter. At his own station some digestion experiments were now being made, and some of the difficulties pointed out were met with there. It was hoped that by practice better work could be done in the future. The stations might expect errors in the first reports on these experiments; considerable experience was necessary, and until it was had the results would not be of great value.

Mr. Plumb said that in digestion experiments conducted at his station a higher percentage of nutriment was found in the dung than had been put into the animal. Those who had large experience in this line were skeptical in regard to the results obtained.

Mr. Thorne said that one difficulty in both digestion and feeding experiments was the great variation in individual animals. This factor could be handled only by dealing with very large numbers of animals; because of its presence he had great doubt in regard to the value which should be attached to many of the German experiments. In the ordinary feeding experiment the possibility of dealing with larger numbers was advantageous. He believed that digestion experiments should be pushed further and with larger numbers of animals.

Mr. Tracy said that last year the Mississippi Station had 60 head of cattle for feeding experiments. After handling them for 90 days it was found practically impossible to conduct the digestion experiment in connection with the feeding experiment, it covered so much ground. The combined action of the stations would be required, and the compilation of the various results might afford the final solution of the question. Until a basis should be fixed for judgment of the condition of the animal's system before feeding the way would remain rather dark and gloomy.

Mr. Armsby said that, so far as his experience went, while individual animals differed as to digestive power, their differences in regard to the nutritive effect of the same amount of food were far greater.

Mr. Atwater wished to confirm the position taken by Mr. Armsby. Some time ago he had made similar experiments on the human subject, and in Germany he had conversed with men who had had a varied experience in these matters. In compiling the data obtained he had been impressed with a general idea that he thought might almost be laid down as a general principle, which was, that the percentage of each nutrient digested and not resorbed by different animals of the same species—human or other—was much more constant than was generally supposed. A large number of cows would individually digest, in this sense, nearly the same quantities from the same fodder, under like conditions. The matter of individual difference came in play when the nutritive effects were considered, the variations in which might be very great.

Mr. Plumb said that the conditions under which digestion experiments were conducted were sometimes abnormal, as, for instance, in the case

of a sheep, which was confined in a small pen so that he could not turn around easily. With cattle, while the conditions were more nearly normal, they were not average conditions. The circumstances under which even the most careful experimenters worked did not seem to be quite fair.

Mr. Armsby said that he gave each sheep about 10 feet square, which allowed plenty of room. The harness was made of carpet web, and the animal was entirely free. He was penned in while feeding and was then let loose.

Mr. Atwater said that he had conversed with Professor Hoyt, who had given special attention to this subject. It was remarkable how little influence the abnormal conditions had upon the actual quantity of nutrients digested as estimated by the system in use.

Mr. Armsby said that in the case of cows he had dispensed with harness, using a pail to collect the urine and a shovel for the dung. He sometimes attached a rubber bag to catch the urine. There was very little irritation of the animals from the harness; they were kept under as natural conditions as many animals free in stall. In digestion experiments he did not consider it essential to catch the urine, but did so in the case mentioned merely to keep the floor clean as a matter of convenience.

A member asked what was the effect of long-continued feeding on a single article of diet, perhaps not a very palatable one, as compared with that of feeding the same article in combination.

Mr. Armsby replied that a direct answer was impossible. If hay were fed alone its digestibility could be determined with considerable accuracy; if corn were then added, the digestibility of hay and corn would be determinable, but it could not be told what was due to the corn and what to the hay. The digestibility of hay was therefore assumed to remain the same. Perhaps the best way was to first feed a little hay alone, next the same amount of hay with a like amount of corn, and for the third period the same amount of hay with a considerably larger amount of corn. If the relative digestibility was found to be the same in the three cases it would perhaps justify the conclusion that the corn did not affect the digestibility of the other fodder; but this would not be an absolute demonstration, and he knew of no way of getting one on the point in question.

Mr. Atwater asked about the effect of carbohydrates upon the secretion of the nitrogenous digestive juices; it had been thought to interfere with the accuracy of the protein determinations.

Mr. Armsby replied that of late the general view had been that that was a question not so much of the amount of carbohydrates as of the digestible dry matter fed.

Mr. Wing read the following paper:

SPECIAL POINTS BEARING ON FEEDING EXPERIMENTS, H. H. WING.

If we exclude from the term "feeding experiment" all the experiments that have been made to determine the digestibility of fodders, we shall find that feeding experiments, with a very few notable exceptions, have been discussed solely from the standpoint of the effect of the chemical composition of the foods used upon the amount and quality of production. Now, while I would not underrate in the least the importance of the chemical composition of a fodder or ration on the animal economy, it seems to me that certain other considerations, that might perhaps well be called the physical relations of fodders and rations, have been entirely too much overlooked in our discussions of the results of feeding experiments.

It is to some of these physical relations that I desire to call your attention to-day, not with the idea of presenting anything remarkably new or startling, but that in the discussion the views of the members shall find expression as to the best means for determining or eliminating these influences.

Palatability.—While we recognize the importance of palatability in a general way, we make no effort to estimate its effect further than to say that good results can not be expected from the use of a fodder that for any reason may be unpalatable to the animal; nor can we even foretell when this is to be an important element in our experiments, as a case in point will illustrate.

Two pens of sheep were being fed on the same ration, of which one pen ate readily and with eagerness, and the other daintily and in much less amount, with the result naturally to be expected, that the one made a fair gain while the other made scarcely any. Here was a large difference in final product that was in all probability in large measure due to the different degrees of fondness of the two pens for the ration. And yet there was nothing to indicate to us at the beginning that the ration would be unpalatable to the one pen and not to the other.

Mechanical preparation.—To the mechanical preparation of fodders more attention has been given than to any other of the physical relations, and considerable good work has been done upon the relative effects of cut and uncut coarse fodders, whole and ground grains, and cooked and uncooked food, but our knowledge of these matters is still imperfect and it is extremely difficult to draw valuable generalizations from the work that has already been done.

Combinations.—In feeding experiments where two or more fodders have entered into the ration it has been the common practice to feed the fodders mixed in the proportions desired, and to feed the same mixture continuously during the course of the experiment. Is it by any means certain that such a mixture will have the same effect upon the animal as the same amount of the same fodders fed singly and alternately? It would seem that here is a field well worthy of careful investigation. Attention is often called to the bad results following the use of a single restricted fodder for long periods of time. Is it not possible that the continuous use of a single mixture, no matter how carefully "balanced," will be followed by largely the same results as continuous feeding on a single article? I do not know that the matter has been investigated, but it seems very likely that the animals under experiment may often be unfavorably affected by such feeding. Perhaps I may be pardoned a personal illustration. Oatmeal mush and milk is universally esteemed a healthful, nutritious, and palatable article of human food, but it has palled upon my appetite since I fed continuously upon it during my freshman year in college, and I do not think were I under experiment that I could be made to thrive upon it.

Consumption of water.—That the consumption of water will vary with animals upon different rations has been often noticed by experimenters; but little effort has apparently been made to trace its effect. From our own somewhat limited experience we have tentatively formulated the proposition that in feeding for flesh the gain in weight is in direct proportion to the amount of water consumed. To this we

have as yet given scarcely the weight of a working hypothesis; the more so as it is in direct opposition to the teaching of German experiments, and it is only mentioned now that the attention of others may be turned in the same direction.

But whatever effects may be due to the chemical composition and whatever due to the physical relations, so called, by far the greatest obstacle that stands in the way of useful generalizations from feeding experiments is the difficulty of eliminating the individual peculiarities of the different animals from the results of the experiment. Of course by using animals whose inherited tendencies are the same—thoroughbreds or high grades—we eliminate to some extent the liability to extreme individual variations; but we know that even with thoroughbreds there are often striking differences in individuals closely related. From the fact that many of these individual characteristics are hidden to the eye or only develop themselves during the course of the experiment, about the only means of counteracting these variations lie in the use of a larger number of animals and in numerous repetitions of the experiment. Formerly it was the custom when two lots were being fed on different rations, to reverse the feeding, so that each lot might for a time receive each ration; but this practice seems to have been almost entirely given up, and with good reason, it seems to me, for often the mere act of change seemed to have as much influence as the different rations.

Finally, I suppose it is hardly necessary to call attention to the fact that we should be extremely cautious in publishing results where the sanitary conditions surrounding the experiment have not been of the best in all respects, or where we have not succeeded in attaining a production that would be considered good under ordinary methods of treatment.

Mr. Atwater thought the paper just read very much to the point, and was glad to say that some of the conclusions therein reached seemed deserving of most careful and thoughtful consideration. The plan of feeding the animals in lots A and B alike, and then diverging and feeding lot A on a narrow ration and lot B on a wide ration, whether feeding for beef or milk, seemed very likely to be fallacious in many cases, because, leaving out of account for the present the individuality of the animals, the residual effect of the ration in the first test period upon the apparent product of the second period was unknown. For example might be taken the case of feeding to test the effect of the fodder upon milk production. This product was dependent upon various factors; it was not elaborated from the food and filtered through the lacteal glands themselves, but it was known that in some way the condition of the animal very materially modified both the quality and the composition of the milk. While the exact facts were at present in darkness, it might be accepted as a convenient working hypothesis that the quantities of protein and fat in the body itself form an important factor in the storage of these substances in the body during the succeeding period. It was probable that the laws of nutrition for the cow were very similar to those for the dog or other animals, and it was known by such experiments as those made with the respiration apparatus in Munich (unfortunately too little understood in this country) to be possible, by changing not simply the amount, but also the composition of the food, to increase or decrease both protein and fat in the body, or to increase either and decrease the other. It was remarkable to see how the interior of a dog could be manipulated, and

why was it not so with a cow? If during the first period the cows of one lot were fed with the nitrogenous ration and those of the other lot with the carbonaceous ration, and the quantity and quality of the milk tested, and then in a transition period of say two weeks, the experimenter passed on to the second period, how could it be known how much of the protein or fat stored in the first period affected the milk product in the other? There was a source of error which he mistrusted would be found so important that a very large amount of the best experimenting in past years would have to be given up. He did not see how any single experiment station could do much to secure the desired results in this line, however narrow might be the problem upon which it worked; but cumulative experience and the aggregation of data would afford what was wanted. For some time he had had in mind the making of a specific suggestion to the experiment station workers engaged in feeding experiments, that as many of them as possible should coöperate in the investigation of some one subject, for instance that of milk production. Were the constantly used dietary standards satisfactory, and how were exact data to be got? When these were obtained it would be necessary in the first place to make the question very narrow, and then unite and follow it up together for a long time, working on a common plan. While not now prepared to suggest either a specific question or a specific line of inquiry, he would be glad to receive from the experimenters interested any suggestions as to the point of attack at which the investigation of any one problem in question should be begun. He would, with the available means of the Office of Experiment Stations, do what he could to collate the latest and best information, European and other, regarding the specific question selected; and then he would be glad to meet with the others interested at Columbus, Ithaca, Washington, Denver, or elsewhere, and spend as many days as might be necessary to arrange plans. The Storrs Station, with its very small means, would gladly coöperate in carrying out the schedule to be made up, and so would Mr. Thorne's station; and though the experiment devised might not prove successful during the first season, some definite results would be obtained by keeping at the work. The suggestions now made were quite general; any of the questions involved might be taken up. He did not know whether the proposed coöperation was feasible, or if it were, whether the first experiments should be made in feeding for beef, mutton, milk, or pork; he had expressly thought of feeding for milk. The first question to be asked, however, was whether it was desired to join in any such work. If it was, he would do all that he could, personally, in the matter, and would invite those who would coöperate to visit Washington and hold a conference for the arrangement of some experiments. He would suggest, first, feeding for milk, and under that either one or both of two questions: (1) the quantities of protein, fats, and carbohydrates to be fed per 1,000 pounds of live weight, and (2) the effect of nitrogenous food

upon the composition as well as upon the amount of milk produced—but this was only a suggestion. He thoroughly believed that work of this kind should be done, and that the sooner it was begun the better.

Mr. Plumb said that the question was one which could not be settled at any one meeting of the Association, involving as it did men and animals and the circumstances surrounding them. Like other men who dealt with cattle in experiment stations, he believed that he had a fair knowledge of stock; but if he went to a dealer in Shorthorns and used his best judgment in picking out three steers for a feeding experiment the Chicago stockmen would laugh at his selection. To illustrate, he had bought ten Shorthorns for a certain experiment. A stockman and one of the trustees accompanied him, both being very capable expert judges—men who attended and exhibited at fat stock shows. The trustee made the selections. When they got the animals home it was considered best to take them around to the barns; they were not suitable cattle for even the ordinary feeding tests. The matter of accuracy—the carefulness of the men who did the work—also entered into the question. Again, in New England one thing was fed and in Texas another; the conditions of the cattle varied in different places. In the past year he visited an experiment station which he considered equal in accuracy of work to any station in the country. Looking at the pig-feeding experiments, and being solicitous to know whether all the food weighed out and credited in the tables as eaten actually entered the bellies of the animals, he looked around and found on the floor and between the ends of the trough some corn meal and other stuff which had been rooted out of the trough, but which had probably been credited to the matter taken into the pigs' stomachs. All these details affected the results, and while he knew that there were many accurate workers in the stations, he thought the bulletins showed that there were some incompetent persons engaged in these experiments. Where was the line to be drawn? Who were to do the work? Who should be the judges? He believed that in the experiments carried on in this country there was a larger item of food wasted by nosing out of mangers and troughs and trampling into the manure than was ever credited, and it seemed to him that the most important point in all the work was accuracy. The work could not be carried on with the students furnished by the college men as helpers; regular assistants, worth their money in carefulness of work, should be employed, for without them the work could not be conducted successfully. He had thrown out the work of a whole winter because he had only students to help him in it. These students were sure they were right, but he had unexpectedly found something going on which destroyed his confidence in the work, leading him to reject it all without reporting it to the workers of the country. He would therefore say that Mr. Atwater's scheme was a splendid one if the primary conditions could only be assured.

Mr. Curtis was sorry to hear such a sweeping assertion against students and their work; it was not just to either. There were students and students, workers and workers, men and men, and it was unjust to discriminate against all students on account of one class. In his own experience with students, which has been large, he had found that about five out of a hundred would become accurate men for experimental work. He did not altogether agree with Mr. Atwater. He did believe that coöperation was good, but both the law and public opinion compelled the stations to experiment in lines productive of direct benefit in their own sections. In Texas it would be very foolish to feed corn meal, at from 75 cents to $1 a bushel, to cattle, hogs, or sheep; a coöperative experiment so planned would be expensive there, and he would not care to publish the results in that State. On the other hand, cotton seed and its products were cheap in Texas, and he made it a prime point to show the farmers the benefits they could derive from them; but in the North these were deemed useless, though really cheaper than what was used there. He therefore agreed with Mr. Plumb in thinking that most of this work would have to be determined upon by the individual States, some of which it might be necessary to divide; Texas, perhaps, was too large for anything in that line, but it was hoped that the ground could be covered by experiments made in the various sections.

Mr. Hunt moved that a committee of three, of which Mr. Atwater should be chairman, be appointed, with power to add to their number at their discretion. The motion was carried, and the Chair appointed Messrs. W. O. Atwater, George E. Morrow, and D. W. Curtis.*

Mr. Sanborn read the following paper:

RELATION OF TILLAGE TO SOIL PHYSICS, J. W. SANBORN.

I am asked to speak upon the subject of relation of tillage to soil physics. The broader relations of tillage to soil physics are biological, chemical, physical, and with reference to cohesion and adhesion.

The biological relations of tillage primarily and mainly are its relation to the air supply of the soil. The degree and character of fermentation in the soil will depend in part upon the amount of air circulating through it. The action of ferments above ground we know are gauged largely by the supply of air. We know that the products of fermentation above ground in a restricted supply of air are quite different from those that occur in the free supply of air. The economic relations of this fact are very important. The same truth we believe is applicable to organic changes occurring below ground; we know that it is. Facts as yet secured, and especially the limited facts at my command, will not warrant any speculations in this field on my part. I can only suggest that biologists of our stations should look very carefully into this side of the tillage question. In speaking of the relation of tillage to the chemical physics of the soil I shall ignore the fact that much of the chemical manifestations that follow tillage operations are due to the organic changes that follow that high degree of fermentation which is due to tillage, and shall speak of the chemical changes as a direct result of tillage.

My remarks will be propositional and assertive, as time will not admit of argumentation over so broad ground. Tillage increases surface soil porosity; therefore

* The committee added to its members Messrs. Plumb and Thorne.

the ratio of the air of the soil which results in hastened soil decomposition. In a trial I found that the immediate surface of the soil increased 6.6 per cent in porosity by tillage. Between different weights of soil per cubic inch, due to varying tillage tools, there was 50 per cent variation found. Tillage increases the bulk of air in the soil. That increased fermentation and oxidation follow increase of air in the soil is shown by the trials of Sturtevant, of the Chemical Society of England, of Woolney, and of many others who have recorded greatly increased losses of nitrogen and of carbon from a tilled soil over that lost by an untilled soil.

Sir J. B. Lawes found that an untilled soil contained less than one half the nitrogen that a long-tilled soil did, notwithstanding the tilled soil was heavily manured. Also that ground under grass increased in nitrogen in ratio to the time that it was covered by grass. Thus a field laid down to grass in 1879 had 12 per cent nitrogen, 15 per cent when laid down in 1874, 17 per cent when laid down in 1873, and 20 per cent when laid down in 1858. Notwithstanding these facts tilled areas, though thus heavily reduced in nitrogen on account of aëration, were yielding yearly more organic matter in crops than the grass plats were with their stores of nitrogen.

Tillage for soil aëration should be limited, as in constant practice it reduces the organic matter too low for absorption and retention of moisture and gaseous matters of the air that may serve the plants. Alternate tillage and grass crop should follow each other for reasons that data given have unfolded.

The constant tillage system of the West has resulted in the fermentation and oxidation of the organic matter of the soil to such an extent that the soil has been reduced in its stock of nitrogen and in its water-holding capacity, and has become physically more compact in the surface through reduced organic matter. The result of this tillage has been the reduction by nearly 2 per cent per annum of the wheat crop of the West.

Tillage for aëration should not occur on loose soils; such soils are already too deficient in organic matter, and therefore in nitrogen supply, in the power to hold moisture, and in their capacity for gaseous absorption. Plowing loose soils should be by cylindrical plows having straight lines on their surface from front to rear, in order to compress the soil and to minimize the aëration necessarily secured in inverting the soil and through the interspaces between the furrows. Such furrows may be and should be flat. They also should be harrowed with wedge-toothed harrows in order to secure the compression of the ground and exclusion of air. Fermentation and oxidation will occur rapidly enough in all such soils, and at the best generally too rapidly. I have handled soils upon the compact surface of which manures were not fully expended for about twenty years. I have handled those in which the effects of manures quickly disappeared, and there are those in which the results of manuring is scarcely visible for more than a year. On compact soils, clays, and heavy loams in plowing, both plows and harrows should be used that increase the bulk of the soil. Such implements we have. Shall we plow deep for this chemico-physical effect? It has been held that tillage by readjustment of the soil particles, throwing them across the interspaces, necessarily increases the bulk of the soil just as wood or rocks loosely thrown together occupy more space or have larger interspaces.

Darwin's famous contribution to science on earth worms has shown that worms penetrate the soil most thoroughly and deeply, forming air passages in so doing. Freezing water increases in bulk one twelfth and thrusts all the particles of soil apart with an irresistible force.

I have been digging much ground for several years and find that after passing the first few inches of organic soil on the surface, the soil thrown out will not fill the same space again; in other words, there is more air space after moving the soil than before moving it. In practice subsoiling has given no gain in this country, as the average of many trials and compilations of trials by myself have shown. Tillage increases the area of the interspaces on the immediate surface of the soil through its lightening influence on the mat of roots, whose chief weight and favorable action is found in the first 6 inches of the soil.

It is doubtful whether more than surface tillage is useful for aëration or is useful at all. On moderately heavy to clayey soils tillage often lumps the soils, as much soil sifting has shown me. The untouched soil has its particles thrust asunder throughout its mass by the action of frosts. Alternate wetting and drying of tilled soils causes the formation of the clods mentioned.

A series of surface-tillage trials in fitting the ground for barley showed a gain of one harrowing over no harrowing that was quite substantial, but excessive harrowing was an injury. I suspect that packing by treading and by chopping the ground follows the first harrowing. If so, it does not bear upon the abstract question of the value of aëration.

TILLAGE TO COHESION.

The main force that overcomes cohesion in the soil is of chemical or of biological origin. The physical influence of plowing or the mere application of direct force to the pulverization of the soil particles that are held together by cohesion is of very small effect indeed and not worth consideration. Cohesion may be indirectly affected by changing the porosity of the soil and by changing its outward covering. The partial dead-air spaces of the soil formed by a grass sward are broken up by plowing. This is effective in the fall of the year, as not only the frequency but the depth of freezing is thereby very materially affected. When moisture surrounds the particles of the soil and insinuates itself into any depressions or around any irregularities of the particles, freezing may result in rending the particles into smaller ones.

The fermentation and oxidation engendered by tillage varies the heat of the soil, as Penhallow has shown. But the variation of a degree or so is not radical enough to merit much attention in its influence on cohesion through the unequal expansion and contraction of the minerals that make up the particles, and the tendency to disintegration thereby induced.

TILLAGE TO ADHESION.

In a recent experiment I found that the direct tendency of plowing is to compress the soil handled into less space. The plow is a double wedge, and should do this. The convex lines on the plow do make occasional rents in the soil. These open spaces where they occur do increase the lump bulk of the soil, but at the expense of draft, and make it questionable whether it is not better to dispense with this shape of the plow and leave the loosening of the soil to cultivators. The air chambers between the lap furrows afford air circulation between masses, as do the rended spots, but not where we desire it between particles of soil. The plow, then, has little influence on the adhesion or looseness of the soil. It serves to secure the supremacy of one plant by turning all foes to it under the surface, and opens the way to the formation of a seed bed on the surface of the soil.

Adhesion between the particles of the soil, then, must be overcome by other tillage tools. In a trial, I found that the several cultivators on the market run at only from 1.31 inches deep to 2.5 inches deep. The effect of surface-tillage implements on soil adhesion is therefore very limited, and with many implements does not increase either the fineness of the particles or the porosity of the soil over the same soil in grass.

What, then, are the pronounced beneficial effects of tillage? First, it destroys the close mat of grass, which greatly reduces air circulation in the soil; second, it insures the supremacy of the plant desired; third, it fits the surface for seeding; fourth, it breaks on old ground the crust that forms as the result of pounding rains and of rapid evaporation, and it readjusts the particles of a fine soil into whose surface pores the rain has run the finer soil, and thus it facilitates aëration. It also affects the movement of water in the soil by the law of adhesion or by capillary action.

These are all purely surface effects, and, as seen, must be largely confined to the surface.

TIME AND METHOD OF PLOWING.

I have said that lap furrows for heavy lands and flat-pressed furrows for light lands were the best. For very heavy lands inclined to be wet, narrow, erect furrows have been deemed the best in England. On a clay loam I found that such a furrow did best when it was quite moist, while a broad furrow did better in drier weather. This was presumably due to effect on the water supply or the capillary action of the soil, and to the direct influence of air currents on the spaces between the furrows.

TILLAGE TO CROP GROWTH.

I have confined my remarks to tillage in its abstract relations. I shall discuss briefly its relation to growing crops.

There are four prominent reasons assigned for tillage of growing crops, viz, its influence on weeds, soil disintegration, soil adhesion or looseness of soil, and the water supply of the soil. Its influence on the heat of the soil I will not discuss. Probably it may make soil temperature more equitable between night and day—a desirable end.

Sturtevant, Hunt, Hays, and others have shown that root cutting of corn is opposed to its most successful growth. Voelker, Sturtevant, and others have shown that the bulk of roots are found in the first 6 inches of the ground, and indeed most of them within the reach of the deeper-surface tillage tools. We must conform our practice in corn cultivation to this information, unless the loss of the assistance of the destroyed roots in feeding the plant is more than overcome by the consequent gains of tillage. These gains are the destruction of weeds, soil disintegration, and water conservation. The weight of the dried weeds of an acre of corn is far less than popular estimation, and very small in their influence on the crop through soil exhaustion. Water is often a pivotal plant food and the measure of a crop. Weeds are usually annuals of rank growth and despoil the crop of water supply at a critical time. Weed destruction is the merest of surface work when watched closely and need not affect the other tillage problems, for a shallow instrument has been run by me with great success. For soil disintegration the running of surface tools, after the close mat of grass has been turned under and the soil has been fitted for crops, will not pay in released plant food a tithe of the cost.

The conservation of the water of the soil can be the only adequate reason for tillage of corn or of crops at any depth or of tillage of crops at all, save as it may prove a cheaper method of removing weeds.

Surface tillage forms a porous layer of earth whose power to move water by adhesion is lessened and whose readjusted particles overlay the freer currents of capillary water and hold it for a time more successfully below the surface. It also restrains heat radiation at night and its influence on vaporization and soil temperature.

In these facts we find the main motives for crop tillage. At what depth should tillage stop to conserve most moisture, and at what depth does the good results from saving moisture become balanced by the evils of root cutting? We do not know, but a compilation of trials in New York (Cornell and Geneva), Ohio, Illinois, Minnesota, Kentucky, Alabama, Missouri, and Indiana show that it should not pass a moderate depth. Whether it should be positively shallow or not is a question to be further explored.

In Missouri I tried many methods of surface tillage and means to obviate the action of capillarity. A very thin mulch of cut straw, of sand, and of earth sown upon various plats was as efficacious, as gauged by crops, as a mulch formed by tillage. In these cases the few weeds that grew were removed by hand; on other plats the scuffle hoe run one fourth inch deep gave the best crop. Other methods were tried, one being a mere scarifying of the surface by spikes driven one fourth of an inch through a plank. The result of it all was that tillage was found unnecessary,

or rather there were no physical conditions found that it was necessary to secure through tillage, as evaporation can be checked and weeds removed without the old-fashioned system of tilling at all.

In Utah for the past season I found that unhoed wheat gave better results than hoed wheat, and that wheat hoed one inch deep gave a better crop than wheat hoed from 2 to 4 inches deep. Potatoes hoed shallow gave 959 pounds, untilled gave 824 pounds, and hoed deep gave 726 pounds. The average result of untilled corn was 164 pounds, of corn tilled deep 135 pounds, and tilled shallow 127 pounds.

While the results on new and comparatively poor land must be uncertain, yet the average of duplicates shows that the great gain from no tillage over the tilled areas could not have been wholly accidental. On our station soil fresh from nature and in a section where weeds are not as prolific as elsewhere, in short on a soil where we had no weeds, the elimination of the weed question gives surprisingly favorable results in view of former convictions regarding the value of tillage.

At present, tilling is the cheapest method of securing these results, but justified invention may seek out other methods.

The efficacious results in checking evaporation of a mere film of earth when sown on the soil three times by me, leads me to believe that very shallow tillage will conserve well the moisture below; if so, it is desirable to secure very shallow tillage, as it suffices to destroy weeds if conducted early. It is especially desirable for the reason that I found that tilled areas dried out faster than untilled areas. There is a double reason for this result, viz: The supply was shut off from below through the physical effect of the position of the particles of the soil and through the greater porosity of the surface soil, whereby air circulated more freely and adhesion was lessened because of the greater diameter, so to speak, of the capillary tubes of the soil. If corn is shallow rooted, or if the roots of our crops are mainly in the surface of the soil, it follows that by surface cultivating the soil in a measure reduces the water of the surface area and cuts the roots within the area moved. For both reasons the new fibers are forced to seek a development below or in an abnormal position.

Nessler's deep-tillage trials indicated that the soil was made drier to the depth tilled, but was made moister below this tilled area. Neither his work nor mine showed whether deep tillage made a more effective mulch for retention of moisture below, nor does the fact that better crops are grown above shallow tillage throw any light on the matter, for the influence of root cutting forbids conclusions on this point. Direct trials only will answer. I have such trials in hand, but the first year's results are sealed to me until our laboratory is opened, which will be next month.

Any general conclusions that we may arrive at must be modified by soil and season. I may draw a minor practical deduction from the effect of tillage in drying out the surface to the depth tilled, namely, that a seed bed should be sown immediately after harrowing. So, too, ground needed for early use can be rid of its surplus surface water every spring by tillage, say by cross-plowing or deep cultivation. The clods that would ensue can be avoided by harrowing as the right degree of dryness is reached. If the soil is inclined to be dry late in the season, or dry weather comes on, this tillage will have saved the moisture of the layer below for the after use of crops.

ROOT PENETRATION.

The notion that we must till either before or after seeding for ease of root growth is of very doubtful force. I have said that the plow rather compresses the soil and that surface-tillage tools merely scratch the surface and at best increase porosity but little, and that frost sunders almost every particle yearly. Again, the penetrating power of roots is almost irresistible. In the marvelously beautiful and deep cañon back of the Utah Agricultural College are thousands of trees growing out of cracks in ledges and great rocks, which stand in a high and dry place unsurrounded by even dirt. It is sweetness of soil and the separation of the particles of soil, coupled with

the right ratio of water, that determines root penetration, and I am inclined to believe that decaying roots, worms, and frosts leave the soil in better condition for root penetration than tillage that converts separate particles into lumps and interspaces where before were pores and particles. I am not quite certain that a loose soil will feed plants as well with either solid or liquid food as will a soil which presses close around the roots.

Last year in Missouri the non-harrowed and non-plowed plats did well, while this year a soil which was never turned during the ages gave me fair results, but far from equal to plowed ground, or about two thirds of a full crop, and for obvious reasons. At the Kansas Agricultural College this year oats did best on non-plowed ground.

The A B C's of tillage are hardly known. We have speculated without knowledge. I do not wish to be understood to be an advocate of non-tillage. The necessity of removing weeds by some means is apparent. The great value of aëration of grass land is unquestioned, as is the necessity of breaking the crust formed on tilled ground in some sections of the country. That tillage restrains evaporation is not doubted. The other functions of tillage are probably exaggerated, or at least are very poorly understood. It is also possible that the factors above mentioned may in part admit of marked modifications.

Mr. Morrow read the following paper:

Station Records, G. E. Morrow.

I think of three classes of station records in which we are all interested, although as agriculturists we have especially to do with but one of them.

First, there should be a record of all decisions, directions, and authorizations by the controlling power. This is important where that power is lodged with a director, but is especially important where there is a board of control. I like the plan of having work decided upon after free conference between all parties interested, but there should finally be not a mere general understanding or verbal authorization, but a definite statement or direction, placed on record at the office of the station. This course will tend to properly fix responsibility, prevent misunderstandings, and secure accurate work.

Secondly, there should be a careful record and classification of expenditures by the station. Not only should the letter and spirit of the law be scrupulously complied with in making expenditures, but the records should clearly show that this has been done. Very few people will suspect any station of forging vouchers, very few would care to have opportunity to examine the bills paid, but all have a right to know in what proportion the funds of the station are used for different classes of work. This information is not satisfactorily given by a long list of unclassified vouchers. At least once a year there should be published a carefully compiled statement showing to any one how much has been paid for this and that class of work.

Thirdly, and this especially concerns us as agriculturists, there should be the most careful record of work done in experimentation or research. Of this there should be—shall I say always or almost always—duplicate records; one retained by the worker, the other on file at the central office. There is danger of relying on memory or on a record made on a slip of paper, and of waiting a little too long before making a proper record. Memory fails; slips of paper disappear; a fire or other accident may sweep away the record of weeks or months; the worker may be called to another field of labor, possibly leaving with a little unpleasant feeling, and he may not respond with cheerful alacrity to after requests for information; he may die, and all that he "has in his head" is lost. There is little danger that the records of work and observations will be too full. Make them as full as you like, and probably the time will come when you will wish they were even more complete. The mass of these reports may never be published. The condensing and arranging for publication is a difficult matter, but the publication will, ordinarily, be the more valuable in proportion to the fullness of the records from which it is compiled.

It will be a help, to suggest only one matter of detail, if each experiment have a letter or number by which it is always to be known. For daily note taking by the worker in field or stable a book is preferable. For his more permanent record I prefer instead of a book slips or blanks which can be filed. Very promptly the worker's record should be taken to the central office there to be copied, allowing the first record to be returned to the worker. For the central record we prefer blanks with proper headings. In this station we have a large cabinet in which these records may be kept, so classified that the record concerning any experiment may be at once referred to. Instead of taking more of your time, let me suggest that if any of you are interested in this matter you may visit the office of this station and examine the system in use here. It seems to me simple, complete, and very satisfactory. I may say this without impropriety as I did not arrange the plan.

Mr. Plumb asked to what extent the details of the experimental work were reported to the central office of the Illinois Station. He supposed there was a biologist, who made a great many laboratory notes, figures, etc. Were all these ultimately recorded in the central office?

Mr. Morrow replied that the matter was largely one of personal discretion; the details were recorded to a great extent, but a working, thinking, inquisitive man would not, of course, consider it necessary to report all the notes made for his own use. He believed, however, that the reports made by such a man were more likely to be too few than too many.

Mr. Hunt said that as a matter of fact the thousands of repeated experiments were recorded though not published.

Mr. Thorne said that his own present system was unsatisfactory. He thought of adopting some such plan as was followed by the clerks in dry goods stores, the use of note slips with carbon between them, by means of which duplicate notes could be made with a single operation, one for the central office and the other to be kept by the worker.

Mr. Hickman read the following paper:

Testing Varieties, J. F. Hickman.

Testing varieties has been and is one of the leading features or branches of, we may safely say, almost every experiment station established under the Hatch act. We may go still further, and assert that this branch of so-called investigation had its birth simultaneously with the founding or establishing of experimental work. To prove this from the written pages of history is unnecessary, because the memories of some of even the younger men of our Association will carry them back to the earliest history of our State experimental farms. It was with these institutions that variety testing found favor, and in more recent years has either been handed down by a predecessor or taken up by an imitator.

Going back to the earliest work of experimenters we find that the testing of varieties has always occupied a prominent place. Beginning with the present list of experiment stations in alphabetical order, we find that from Alabama down to Wisconsin, the entire list of stations, numbering more than fifty in all, are more or less engaged in variety testing. Taking this fact alone as a basis, I think we have reason to believe that variety testing comes in as one of the legitimate lines of station work. One of two things is certain: either variety testing is a lawful part of the work of stations, or four fifths of the stations now in operation are engaged in investigations which are not strictly in accordance with the intention of

the Hatch act; and if this latter be the true rendering of the law, then those directing the lines of work in many cases have started upon a wrong assumption.

I am not sure whether it was intended that I should discuss the propriety of stations conducting variety tests or not, but certainly the point is germane to the subject on hand, and while I do not intend to elaborate upon this phase of the question, I will leave it by making this inquiry: If the experiment stations do not do it, who will? Our subject assumes that it is or may be the work of stations, and I shall treat it with that understanding, and shall attempt to discuss it under the following heads:

(1) Where shall the work be done?
(2) When shall it be done?
(3) How shall it be done?

The first place to conduct such an experiment or test is upon the station grounds, under the eyes of a vigilant superintendent and within reach of other inquiring minds, for even the best of men can not see everything that such an experiment suggests. While we may be experts in our business, experience teaches us that a novice or an amateur may think of something and suggest the same concerning the very work upon which we claim to be quite proficient.

If other suitable places can be secured in different parts of the same State, the variety testing at the station should be duplicated on as many representative soils as the means of the station will permit, or as the necessities of the case may seem to require. If the work is thorough, complete, and satisfactory in any State, it will be only after the tests have been made upon the lowlands, the highlands, the hillsides, the hilltops; the black lands, the clay lands, the sandy soils, the peat soils, and the various other soils which may constitute any large area of the State in which variety testing is undertaken.

Under this first head, Where shall we undertake the work? comes one of the most important points which we have to consider, and that is, the uniformity of the soil upon which such an experiment is conducted. To attempt to make a variety test upon irregular soil, or upon soil unequally rich in plant food would be simply to thwart the intention of the work, to destroy confidence in the kind of work, and to mislead in the final results. Then the first requirement is to have a piece of land about which there can be no question as to its uniformity in natural or added fertility.

The second heading brings up the question, When are we justified in making a variety test? I answer, if at all, certainly not until the interest in such a test is sufficient to justify its being undertaken. The interest referred to will be manifested by letters received, asking about this or that variety of wheat, oats, corn, tobacco, sugar-beets, cotton, or perhaps vegetables or fruits. Visitors at the station or farmers at institutes or other gatherings will bring these subjects to the surface, and thus indicate the timeliness of such work.

Having decided that it is the proper thing to do, and having secured the uniform tract or tracts of land, as suggested above, do not for a moment suppose that the only thing left to do is to secure the several varieties of grain or other field crop under consideration, to plant them and reap the harvest, and then publish a long list of names giving yields per acre, etc., without so much as estimating what the object of the test has been. But before starting out do some wide and deep thinking; settle upon some definite point to be gained; do not be too diffuse and attempt to cover too much ground with a single experiment; concentrate your efforts upon one or two most important points to be gained; shape your plans and ideas so as to bring out those points most forcibly; have a clear-cut and clean understanding of them yourself; and then when your work is done you will have no difficulty in placing the ideas and points gained before those whom the experiments were intended to benefit in a clear, concise, and impressive manner. In plain, simple words, know exactly what you want, and then you are ready to begin work.

Having decided where and when to do the work it remains now to tell how to do it. The amateur and the novice would say, "Oh, that is a small matter." But after

some few years of experience I have been convinced that it is no small task to properly conduct a variety test. I am fully persuaded that I know far less about it to-day than I thought I knew when I first undertook the work.

To select a piece of uniform land, lay it out, and prepare it so that the several plats into which it may be divided are regular in size, uniform in substance, and of equal elevation and exposure, requires good judgment, well-tempered discretion, and experience beyond what we find in most heads. To select the land by mere superficial appearance is not safe, even with the expert; either he or somebody else should have a previous knowledge of its productions. I claim that the perfect experiment in variety work can not be made until after one or two years' experience with the soil upon which it is made.

Having gained a clear idea that the land selected is satisfactory in every particular, then the preparation of the same becomes a matter of vital importance. To plow the land equally deep all over requires a good, steady team, with a level-headed and painstaking driver holding the lever or plow handles. If the land is manured with yard manure much care will be required to be sure that it is evenly spread and that it is of equal strength, otherwise results will be vitiated and misleading conclusions follow. Whatever other tillage is given, the leading object must be uniformity of work. The seed bed properly prepared does not finish the necessity of care; but upon equal sized plats equal quantities of seed should be used; approximate amounts by guess will not suffice, but actual measurement, either by the scales or bulk measure, must govern quantity. Quality, regarding cleanness and purity, are important factors, and can not be disregarded.

The varieties to be tested are usually numerous and are being continually added to; therefore one of the first things to be done seems to be to reduce the list by eliminating those varieties which after one trial we are satisfied will not be a success upon our soil or probably in our climate. A single test will not be sufficient to reduce the number very materially, because the seed may have been imported a considerable distance and may have lacked vitality, or the climatic conditions may have been quite unfavorable, while further testing may bring out some desirable qualities and later develop a valuable variety.

The second way of reducing the number on the list is by detecting synonyms. This may be done after the first year by a careful comparison of characteristics of the several kinds under consideration. Those having like points of similarity, such as likeness in growth and quality of product, time of maturing, and other distinguishing features should be grouped together, so that in the second planting like varieties may be placed on adjoining plats and their identity confirmed or points of dissimilarity more readily recognized and more clearly defined.

Just at this point in our variety testing a word of caution should be noted. That particular point to which I would call attention can not be better illustrated than by relating this fact, namely: that we may, after a careful examination, decide two kinds of wheat to be the same in their tillering qualities, in their manner of growth, and in their botanical construction, but may find that one matures a little earlier than the other, or that the color of the berry or chaff is not identical, and therefore the wheats are of different varieties. Any one of the three points named may be misleading, for after the same two varieties in question have been raised near to each other for a series of years these characteristic differences may entirely disappear. It is a fact that the color of the grain is affected by change in locality in which the grain is raised; whether it is due to a change in soil, to climatic differences, or to the character of plant food applied to the soil I am not prepared to say, and a mere conjecture in our work should not be entertained. Especially is this true where so many important points are likely to enter into the cause of such a change.

The various ways of propagating and hybridizing are continually multiplying the number of varieties at a rate that indicates a continuation of a long list for some time to come. Besides these sources of new varieties, we must always expect to

have some unscrupulous seedsmen, who will give new names to old varieties merely for the sake of the dollars and cents it will return to them.

In view of the foregoing facts, the experimenter who undertakes to test varieties must do so knowing that before him lies an unending task. He must realize that he will have to come in contact with some very puzzling and perplexing questions. He must also be prepared to combat unscrupulous companies and individuals; to stand up for that only which he knows to be correct. Having singled out of many varieties a few that are worthy of continued trial, he should then begin to inquire by practical experiments to what kind of land each variety is best suited. This, according to my own experience, is a leading question from persons seeking information on varieties, and very frequently comes in this form: "What variety of wheat would you recommend for a clay soil, a black soil, a sandy soil, a loam?" etc. These are questions which to the inquirer are of vast importance, and if the experimenter is able to answer these properly and with some degree of accuracy he has accomplished something which the farmer might not be able to do for a series of years by making experiments personally. He may thus have saved or rather have made for him hundreds of dollars, which he would have lost by experimenting for himself. These points of specific information can not be gathered in a single season, but will require time, patience, and experience such as none of our stations have had as yet. Since it will require a series of tests to decide such questions, it would seem an economical and safe plan for the stations undertaking such work to rent or lease a number of pieces of land in different parts of the State for a series of 5 years, with the privilege of a second lease if at the expiration of the first period the further test seems desirable. I am aware that many would advocate the plan of having the farmers themselves do this work. But I feel quite as certain that those approving or favoring that plan have not had any experience in attempting to carry out such a scheme.

The Ohio Station has made the effort to conduct variety tests by the gratuitous distribution of seed, sending with the same a blank indicating the kind of answers expected when the crops were gathered, and at the same time a postal card to be returned by the one receiving the grain. The postal was already written and indorsed, and needed only the signature of the person and to be dropped into the office to insure us that the grain sent had been received. These postal cards were in almost every case promptly returned, but this was too often the last heard of the experiment. I am very safe in saying that 50 per cent of such tests have never been heard from, and with the other 50 per cent (if the test was on wheat) we could pretty safely count on 10 per cent being reported as failures without any further explanation, 10 per cent sowed on corn ground among the corn, 5 per cent sowed on potato ground, 5 per cent on oats stubble, 5 per cent on clover sod plowed under, 5 per cent on ground that had been in wheat the previous year, 5 per cent on land top-dressed with a heavy coating of yard manure, 5 per cent on land fertilized with homestead fertilizers at the rate of 600 pounds to the acre. In view of these varying conditions of previous management and tillage it was simply an impossibility for any one to tabulate specific information. I have also tried to give directions from the home station, but without success.

The Chairman requested Mr. King to speak upon the subject,

WHAT DOES A LYSIMETER TEACH? F. H. KING.

Mr. King said that his selection was an unfortunate one. He had been invited to consider the question some time ago, when it had seemed impossible for him to attend this meeting. He had had no practical experience with the lysimeter. During the past year his work on soil moistures had been confined to studies made in the field, his only approach to lysimeter work being studies of the rate of capillary movement and of the rate of evaporation from a cylinder of soil 4 feet in length and 1 foot in diameter, a study with reference to the bare soil without vegetation. From his impressions on reading results of experimental work with lysimeters he had become

in some measure prejudiced; he saw no hope of obtaining from them palpable results specifically applicable in field investigations or to field conditions. He thought it most important in the study of soil physics to make a wide study of field conditions and get at the facts irrespective of any preconceived theory. It seemed that in this, as in a great many other matters, investigators stood where Darwin would have stood had he lived a hundred years before his time and had attempted to build up the great doctrine which bore his name. He could not have succeeded, for at that time the facts had not been collated and the needful basis for reasoning was absolutely non-existent. Lysimeter and laboratory experiments might afford suggestions, but the conclusions derived from these sources should not be carried over into the field, which ought to be studied directly. In Story's Agriculture the capacities of different kinds of soil for moisture were given, but in his own study of that question as it presented itself in the field, involving the examination of more than 2,000 samples taken in different places, he had been unable to obtain results anywhere within experimental or scientific reach of those given by Story. To illustrate: The highest ascent of moisture that he had found in clay within a foot and a half of permanent water in the ground and immediately after long rains was only 30 feet, whereas the book made it much higher; and the highest percentage of moisture he had found in sand, even when taken below standing water in the ground, was 4 per cent below that given in the work referred to. In the approximation to a lysimeter which he had studied in the laboratory with a current of dry air at a high temperature passing over the surface of the soil the surface never became dry even when the water-table was maintained four feet below the surface; it remained wet throughout the experiment, covering more than six months of continuous action. All knew that this condition did not exist in the field where the surface did get dry; therefore it seemed necessary to make further studies of Nature as she exists, rather than, or at least side by side, with Nature as she might be produced.

On motion, at 12 o'clock m. the meeting adjourned.

THE PERMANENT COMMITTEES ON AGRICULTURE AND CHEMISTRY.

JOINT SESSIONS.

Morning Session, Wednesday, November 12, 1890.

The meeting was called to order at 10 a. m.

It was stated that the topics to be discussed in the joint meeting of the committees on agriculture and chemistry were as follows:

Artificial digestion*	Paul Schweitzer, Missouri.
Coöperative field experiments with fertilizers	W. O. Atwater, Washington, D. C. C. L. Ingersoll, Colorado.
Methods for the analysis of milk	G. E. Patrick, Iowa.
A standard milk test	G. E. Patrick, Iowa.
Is a digestion experiment fallacious?	H. P. Armsby, Pennsylvania. W. H. Jordan, Maine.

Mr. Atwater read a paper on coöperative field experiments with fertilizers, an abstract of which follows:

The experience of the stations in field experiments with fertilizers was referred to. A number had carried them out on the plan detailed in Circular No. 7 of the Office of Experiment Stations on Coöperative Field Experiments with Fertilizers. Among the objects of these experiments are—

(1) To work directly upon farm lands in different localities and aid owners in learning the deficiencies of their soils and the requirements of their crops.

(2) To help farmers to become familiar with the forms and action of commercial fertilizers and to better understand their profitable use.

(3) To encourage a spirit of investigation, and thus to gradually develop farm experimenters whose work will be useful to themselves and their communities, and who will serve as a means of connecting the stations more intimately with the agriculture of their respective States.

(4) To gradually accumulate data upon which may be based generalization of values regarding the wants of our soils, the action of fertilizers, and the feeding capacities of different crops.

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* Not presented.

The experience of a number of stations was cited in illustration of the value of such experiments in the ways referred to. While they had been in many cases unsuccessful, yet on the whole those stations which had carried them out the most thoroughly had found them useful in a very high degree.

Special stress was laid upon the sources of error, the principal ones being variations in soil and the effects of plant food accumulated in the soil in residues of previous crops and from previous manuring. One great difficulty is the variation in the water supply from the subsoil. We do not realize until we have examined into the matter how great may be the variations in the subsoil where the surface soil looks quite uniform. It is not simply the supply of plant food but the mechanical condition of the soil and subsoil, and especially the supply of water which interferes with the results of field experiments.

The necessity of a more careful geological, chemical, and especially physical study of the soils and subsoils was insisted upon. It was also urged that the methods of field experimenting which experience has shown to be so valuable for obtaining information as to the effects of fertilizers upon our ordinary field crops and their different capacities for obtaining food from natural sources may be most advantageously applied to garden vegetables and fruits; in other words, that the station horticulturists as well as agriculturists may find here a way of doing most useful work.

Mr. Ingersoll read the following paper:

Coöperative Field Experiments, C. L. Ingersoll.

The subject on which I am asked to give a few thoughts is one which has engaged the minds of many of our experimenters. There are many considerations which, for the present at least, seem to forbid the active coöperation of many stations, unless it may be in the line of the determination of the use and action of fertilizers. For us in the Far West this question, while valuable, is one to engage our later consideration. I can see, however, that in certain directions Ohio, Indiana, and Illinois, for example, could unite in the study of questions that pertain to all of these States.

The board of agriculture in Colorado in organizing the experiment station, instructed the council in a general way (1) to plan popular experiments which would meet the immediate demand of the people; (2) to arrange a small amount of scientific work and carry it forward over a series of years to enable the station to determine some of the deeper questions involved in experiment station work. In Colorado the questions which lie at the foundation of our agriculture are:

(1) Water supply, division and use.

(2) Climatic conditions as modified by lack or distribution of rain-fall, prevailing winds, elevation, per cent of sunshine, etc.

(3) What to grow under these conditions.

(4) The particular varieties that are likely to be best suited to our climate, and the system of culture and irrigation which we must use.

You can then see that to the Colorado board of control and to the average farmer questions that are more deeply scientific have but little favor and would not be well received at this time; and while we may do some work looking in that direction, it must for some time to come be limited because of the great amount of fundamental work which must be performed. We of Colorado can join in some of this work with

our neighbors. With Utah, Arizona, and New Mexico we can coöperate on matters which pertain to the arid region. With Kansas, Nebraska, and Dakota we can coöperate to a more limited extent. For example, we find by experimentation that the sugar-beet can be successfully raised and with sugar content enough to warrant experiments in raising them for profitable use in sugar manufacture. Whether we acknowledge it or not, the question of profit must influence us in our work and to some extent determine its lines. In this pushing, active age, the close of the nineteenth century, when competition is sharp, when the markets of the world are constantly changing because of movements of population and the opening of lines of traffic in many directions, because of the opening of new areas, and the great increase of certain products suddenly thrust upon the market, all these factors influence agriculture to a greater extent than we are willing to admit.

Amid all this the demand is made for work the interpretation of which shall bring to the farmers and stockmen of our country dollars and cents. To a certain extent we must meet this demand, and as we go West the demand seems to be more imperative. The older portions of the country are more willing to wait because their conditions change more slowly and the agriculturist can have time to adapt himself to the modified conditions.

On the whole, I do not believe that coöperative field experiments are to any extent practicable at this time. When 10 or 15 years of experimental work shall have been performed, when this Association shall be as many years older, then little by little and item by item this work may be taken up and carried forward under the general auspices of the Department at Washington, and in the light of its experience and that of this Association.

In the discussion which followed, Mr. Frear said one point that did not seem to have been touched upon in the papers already read was the matter of soil tests in the older States, where the farmers wanted to know what would be the most profitable to put upon their soils. The question of a maximum crop was not simply a question of maximum fertility, but of the best soil preparation, climatic condition, and water supply, and it was very often true that the climatic conditions and those of water supply were the ones that had the greatest influence upon the development of the crop. If negative results were obtained with fertilizer experiments, it showed that the soil did not require the addition of the ingredients contained in the fertilizer for the cultivation of the maximum crop, and the farmer learned what he wanted to know. Therefore the soil test was valuable, economically considered, without reference to its educational value, which should not be underestimated, and hence it seemed that in those States where fertilizers were needed there was a very great work to be done in the way of properly coördinated experiments with fertilizers, as economic soil tests simply, and not as studies of physiological matters.

Mr. Thorne said that the necessity for great care in the selection of soils for these tests should be emphasized. He thought that very much more attention than had been paid heretofore should be given to the geological history of our soils, beginning with drainage and exposure, which in some experiments made at his station seemed to be the all-important matters, the success of the experiments depending upon them. Referring to a statement made by Mr. Atwater, he deemed it no less important that the farmer should know how to maintain the

fertility of his soil, even though it be quite fertile already, than that he should know how to bring up the barren field.

Mr. Atwater said that Mr. Thorne would find the application of certain fertilizers profitable on soils yielding 50 or 60 bushels of corn to the acre, and would probably agree that the application of these fertilizers for the sake of maintaining high fertility was also profitable.

Mr. Thorne said that the fertilizers would prove equally valuable in maintaining a high degree of fertility whether the soil yielded 30 bushels of wheat to the acre or only 15 bushels.

Mr. Hunt then read the following paper:

Equalizing the Irregularities of Plats, Caused by Defective Germination, T. F. Hunt.

The first requisite, of course, is to obtain good seed, so that the errors may be reduced to the smallest limit. In getting seeds from various sources equally good seed can not be obtained. We must experiment with the possible, not with the ideal.

With small grain, testing the sprouting power of the seed and sowing enough to offset the defective germination suggests itself. There are two fatal objections to this method: First, variations due to the method of testing are so great as to vitiate results; and, second, there is no direct relationship between that percentage of seed that sprouts under favorable conditions and that which grows in field culture.

Thirty-two varieties of oats were tested this spring in the Geneva apparatus, at two different times, 100 berries being used in each case. The mean temperature for the two periods was 60.4° and 60.1° F. The average variation in the result of the duplicate test was 6 per cent, and for nine varieties the variation was 10 or more per cent. With such variations, who would wish to decide how much seed to sow to compensate the defective germination? But suppose the method of testing perfect, what then? Mr. McCluer tested 110 varieties of sweet-corn in the greenhouse and afterwards compared the percentage which sprouted there with that which grew in the field, in order to find the relation of the vital power to the per cent of live seeds. For purposes of comparison he divided the seeds into four lots. The first lot included 32 varieties, of which 90 to 100 per cent sprouted; the second, 37 varieties, of which 75 to 89 per cent sprouted; the third, 24 varieties, of which 60 to 74 per cent sprouted; the fourth, 17 varieties, of which 45 to 59 per cent sprouted. Omitting fractions, the following was the result:

	1	2	3	4
No. of varieties in each lot	32	37	24	17
Average per cent of seeds germinating as shown in greenhouse tests	95	83	69	52
Per cent of seed germinating in field	76	61	60	55

How little indication does a test made under favorable conditions give of what will be the result in field culture under unfavorable conditions!

Any particular method of seed testing is not the most favorable for all classes of seeds. Of 82 varieties of corn tested in 1888, 94 per cent sprouted in the Geneva apparatus, while 80 per cent grew in the field. Of the same number of varieties tested in 1889, 95 per cent sprouted in the Geneva apparatus and 80 per cent grew in the field.

On the other hand, I have tested Kentucky blue-grass seed, from 17 different seedsmen, with the following results: In the Geneva apparatus, less than 2 per cent sprouted; in soil in the greenhouse, 9 per cent; and in soil in the open air, 21 per cent.

These tests show that no calculations based upon the sprouting of seeds in seed tests would be sufficiently trustworthy as a means of equalizing results due to defective germination.

With corn, it has been the custom at some stations to report yield and corrected yield. The corrected yield is the yield which would have resulted had there been a perfect stand and the yield with a perfect stand had been in the same ratio of corn to stalks as the yield from the fewer number of stalks. As a reason for declining the use of this method in the experiments with corn which have been reported from this station, I have heretofore stated that corn growing at different thicknesses would not yield in proportion to the number of stalks. I base my opinion on the following experiment: Corn was planted during the past three seasons at six different rates of thickness, ranging from 47,520 to 5,940 kernels per acre. From two to five plats of each thickness, differently distributed, were planted each season.

The following table shows the number of kernels planted, the number of stalks, and the bushels of corn harvested from each of the different plantings during each of the seasons given:

Number of kernels planted and the number of stalks and bushels of corn harvested, 1888-90.

No. of plats.	No. of kernels planted per acre.	1888.		1889.		1890.	
		No of stalks per acre.	Bushels of corn per acre.	No. of stalks per acre.	Bushels of corn per acre.	No. of stalks per acre.	Bushels of corn per acre.
5	47, 520	29, 460	89	36, 700	61	37, 390	26
5	23, 760	17, 100	95	19, 820	86	19, 820	48
5	15, 840	13, 940	87	13, 270	91	13, 920	55
4	11, 880	12, 350	83	11, 110	93	11, 280	63
3	9, 504	11, 540	72	9, 170	82	10, 270	62
2	5, 940	8, 200	60	6, 260	56	7, 300	50

This table is sufficient to show that the yield of corn was not in proportion to the number of stalks harvested. The following table, giving the pounds of shelled corn for each 100 stalks harvested, brings the point out more clearly.

Pounds of shelled corn for each 100 *stalks harvested.*

No. of plats.	No. of kernels planted per acre.	Pounds of shelled corn for each 100 stalks.		
		1888.	1889.	1890.
5	47, 520	17	9	4
5	23, 760	31	24	14
5	15, 840	35	39	22
4	11, 880	38	47	31
3	9, 504	35	50	33
2	5, 940	41	50	39

There was not only a great variation in the ratio of corn to stalks for the different ratios of thickness, but the variation in the ratio was greater some years than others.

The plan of planting more kernels of corn than the number of stalks desired and then thinning to the desired number has doubtless suggested itself to every field experimenter. This plan is helpful, and in some experiments practicable. It must be done, however, at the right time and with care, or else the disturbance from thinning will be worse than the evil of irregular germination. It must also be remembered that the stand will not be perfect even with this precaution. The thinning will not be absolutely accurate, and many other causes will combine to cause slight irregularities. In some experiments this method can not be practiced, as, for example, when corn is planted at different times, for the variation in the germination is here

one of the results to be studied. Before leaving this portion of the subject, I wish to point out that while the irregularities due to defective germination is an element not to be ignored, it is of less account probably than the irregularities arising from a multitude of causes which affect the result of an ordinary field experiment. With small grain especially, and with corn to some extent, as shown by the previous table, the plants themselves tend to equalize the irregularities by tillering or suckering and by yielding a greater or smaller proportion of grain to straw or stalk.

The results with oats in experiments in sowing different amounts of seed per acre made during the past 3 years at the Illinois Station illustrate this point. The following table gives the relative quantity of seed sown and the relative yield of oats during the three seasons:

Relative quantities of seed sown and of oats harvested, 1888–90.

Plat.	Relative quantity of seeds sown.	Relative yield.		
		1888.	1889.	1890.
1	100	82	97	75
2	87.5	93	100	85
3	75	96	91	95
4	62.5	100	84	100
5	50	97	82	60
6	37.5	98	63	74
7	25	95	70	87

As showing how the plant adapts itself to its circumstances, the following data are instructive:

The number of plants growing on $\frac{1}{10000}$ acre was determined in four parts of each plat, and the number of culms harvested on similar areas ascertained; the averages of the results are given below. Undoubtedly there is a very wide limit of error in the method used, but it is sufficiently accurate to carry the conviction that the plants are held in check by their neighbors or spread themselves as their resources, soil, water, air, and sunlight, will allow.

Plat.	Number of seeds sown.	Number of plants.	Number of culms harvested.
1	214	93	135
2	187	85	123
3	160	86	135
4	133	67	102
5	107	52	117
6	80	45	105
7	53	28	85

The method which I wish to propose to equalize the irregularities due to defective germination will also equalize the irregularities produced by many other causes. This method is simply a duplication of plats. What is wanted is not a few large plats, but a large number of small plats. Here is a table giving the relative yield of 18 pruned and 18 unpruned rows of corn. Each pruned row was adjacent to the unpruned row with which it is compared; the same quantity of seed was sown and the cultivation was similar.

Relative yields of pruned and unpruned rows of corn.

Row.	Pruned.	Unpruned.	Row.	Pruned.	Unpruned.
1	63	100	11	70	100
2	73	100	12	81	100
3	63	100	13	70	100
4	100	100	14	100	100
5	67	100	15	79	96
6	83	100	16	77	100
7	79	100	17	62	100
8	87	100	18	66	100
9	81	100			
10	75	100	Average	76	100

These 18 comparisons were made on 8 plats. The average relative yields from the pruned and unpruned portions of the plats were as follows:

Average relative yields from pruned and unpruned portions of plats.

Plat.	Pruned.	Unpruned.	Plat.	Pruned.	Unpruned.
1	82	100	6	72	100
2	80	100	7	83	100
3	76	100	8	79	100
4	72	100			
5	70	100	Average	77	100

Thus I have 144 comparisons between the pruned and unpruned portions. In these 144 comparisons there were six cases in which the pruned row yielded more than the unpruned, three pairs of rows in which the yield was the same, and 135 cases in which the yield was in favor of the unpruned portions. I have not told you anything about the size of the plats nor given you any information about the stand. Yet, have you any doubt that the difference in yield was in this instance directly the effect of root pruning?

The pruned and unpruned rows compared were only 1.360 part of an acre. The 144 comparisons were made on 0.8 of an acre.

On the other hand, here is another experiment which was made on 1.3 acres. The tract was divided into three equal parts. One plat was drilled with corn; on another the same amount of seed was planted in hills, and the corn cultivated one way. On the third, the corn was planted in hills and cultivated both ways. The kind and quantity of cultivation was the same on each plat. The yield was as follows:

	Yield per acre.	Relative yield.
	Bushels.	*Bushels.*
Hills, cultivation both ways	64	100
Hills, cultivation one way	59	90
Drills	50	78

Please notice that the greatest difference in relative yield was substantially the same as in the root-pruning experiment before mentioned. Notwithstanding a half more land was used, would I be justified in claiming with any degree of certainty that the difference in results was due to the method of planting and cultivating the corn?

No field experiment can be considered at all satisfactory unless there are at least two plats devoted to each item of the experiment whose results agree more closely than do those devoted to different items of the experiments. Of course if one gets

corresponding results during a series of seasons, that is, has duplication by repetition, he may justly consider his results trustworthy; but if irregularities occur he does not know whether the difference is due to the season, soil, or accidental causes. He has no means of getting at the limit of error in his work.

In my judgment, three plats would be the best number, usually, to devote to a given item in an experiment. If an accident occurs to one of the plats we still have duplicate results. If one plat gives results considerably different from the other two the experimenter's attention is at once directed to seek the cause of the variation.

The plats need not be large. It is much easier to get comparable results from 10 tenth-acre plats than from 10 one-acre or 10 ten-acre plats. The large plats have no compensating advantages over small plats properly duplicated, but they have disadvantages. I find from one fortieth to one tenth acre plats answer well for many plat experiments. For most experiments with small grain I like twentieth-acre plats; and for corn, where it is desired to cultivate the plats with horse machinery, I like tenth-acre plats. For variety tests of corn I have used fortieth-acre plats with fairly satisfactory results if any variety tests may be considered satisfactory.

The plats devoted to a single item of an experiment should be as widely distributed over the tract as the separate items of the experiment will allow. It is not sufficient to merely ascertain the results from equal parts of a plat, although it is often desirable as an additional measure.

While I do not by any means think plat experimentation is the only method of agricultural research, I do think there are certain problems of importance to the farmer, for whose benefit the stations were founded, which are capable of demonstration by this method. With a proper duplication of results and a scrupulous regard to small details, I believe many of the irregularities of results in plat experiments will disappear, and with it the statement met with in some quarters, that plat experimentation is merely a means of pacifying the farmer.

Mr. Redding said that while he had been much interested in Mr. Hunt's paper and figures, it seemed particularly instructive to those who grew corn as closely as wheat and oats were grown in the South. He would suggest to those experimenting in corn, cotton, and other cultures involving the hill system or a small number of plants, varying from 1,800 to 3,000 plants to the acre, that when stands were defective in test rows the only scientific method of correction was to equalize the stands.

Mr. Morrow said that all experimenters in this line regarded with profound interest and great personal gratitude the work of Sir John Bennet Lawes, of Rothamsted, England. The young experimenters should not be discouraged so long as they do their best. No one could now doubt the care, patience, and skill evidenced in the work at Rothamsted after fifty years of experiments, but on his visit there last year he had been struck with the variation in stand of the root-crops, and as he saw the things that could not be avoided even with the best of care, and that those wonderful experiments in wheat did not mean just what they would if every stalk was just where it belonged, he had thanked God that we were not doing so very badly even in young America. If we did not get perfect results he should not feel that it was our fault. The young gentlemen should take courage and go ahead, recognizing that there are hosts of things that can not be done. Seeing that even Rothamsted could not control Nature and make her do exactly as we wished, had been a great help to him.

Mr. Armsby said that at the Pennsylvania Station in the past season they had eight plats (four pairs) of corn grown in drills for silage. The stand upon these plats was somewhat irregular. Instead of attempting to count the stalks, he and the assistant agriculturist went through each plat from end to end and formed a general idea of their appearance and nature. They then repeated this survey, staking off those portions which it was decided to reject, using as a criterion their best judgment as to the average yield of the plat and rejecting such portions as were manifestly wrong; for example, one portion where a heavy rain had made a washing and the crop was irregular the duplicate plats were separated by four other plats. The results of the four pairs of duplicates agreed very closely. While this of course was insufficient to prove the value of the method, it might serve to raise the question whether an experimenter's individual judgment was not a legitimate means of correcting errors in plats and whether it was necessary to rely upon mechanical methods for correcting yields. If the impartial estimate of one, two, or more experimenters was a legitimate means for such a purpose, the method might possibly lead to good results.

Mr. Myers said that there were difficult questions involved in plat selection. He tried to follow the advice furnished by the Department of Agriculture, but the problem in his plat experiments was to find a system that would answer the most questions from the farmers of West Virginia. In that State conditions were different from those in Illinois. Here was a great loam prairie, with the strata lying almost horizontally, so that a problem solved for Champaign would be solved for an area of perhaps 100 miles in diameter; whereas in West Virginia, for a stretch of 300 miles from one end of the State to the other, the strata lay nearly vertical, sometimes broken by river courses. The results of plat experiments on one stratum in the coal formation would differ greatly from results obtainable on any other stratum in that formation. If, for example, he stated to the farmers the results for watermelons at his station, they would make the trial and declare the statement a humbug, because their work would be subject to different chemical and geological conditions. Mr. Scovell, he thought, had most magnificent opportunities for carrying out plat experiments, his soil being uniform and his geological strata lying beautifully; but his experiments would answer only for the blue-grass region of Kentucky; on the tipped-up region extending from South Carolina to Vermont his deductions would amount to nothing. Outside of the simple problems involved in the feeding of plants, the excellent experiments made in New Jersey, Connecticut, and Massachusetts solved nothing for the farmers of West Virginia, where the geological formations were entirely different. So far as his investigations went, this matter had been wholly neglected in the plat experiments made in this and other countries, but attention should be paid to it in order to reach results worth having. The geological formation—coal, limestone, alluvial, etc.—

should be stated. Results obtained on the rich prairie land of Illinois were worth nothing in West Virgina or on the red hillsides of Georgia, solving nothing but the feeding capacities of plants.

Mr. Myers said that while he admired the good intentions of Mr. Atwater in regard to coöperative experiments, he could not altogether agree with him. Men in Ohio, Illinois, and Indiana could perhaps coöperate in a certain line of experiments, but farmers on rich prairies cared nothing for fertilizers. It was useless to pile corn in a pig pen and say, "Go in, pigs; we will give you more corn," when the pigs already had more than they wanted. A soil could be overfed or fertilizer work wasted upon it, which was a pity except so far as scientific interest was concerned. The geological problem contained the point he particularly wished to enforce. What did the results in these plat experiments mean? Probably no man present could tell from the results of his own experiments what their effects would be upon the soils in West Virginia, because the geological problem had been neglected, at least in published results.

Mr. Curtis said that he would go further than Mr. Myers and speak in regard to the especial value to the whole United States of Mr. Atwater's position in the matter of coöperative experiments. He thought that both gentlemen touched the borders, but failed to reach the center of the trouble. It would be well for Mr. Atwater not only to plan the general character of plat and fertilizer tests, but to define more clearly the conditions on which they should be based. For example, a set of experiments could be carried on in different parts of the country under temperature conditions as nearly alike as possible; another set could be conducted under similar geological conditions, and another set under like conditions of moisture. The question was, whether with these different conditions, results could be averaged, and whether Mr. Atwater could get something reliable from the average results in coöperative tests. The speaker differed from Mr. Myers in believing that he could. If certain fertilizer tests gave results on rich land and also on poor land, it was immaterial that the yield on the former was double or triple that on the latter; if the same relative proportions were the same, conclusions could be drawn from such results.

Mr. Hays said that in Minnesota the wheat farmers demanded fertilizer experiments and the station had made them, but the results were not yet summarized. In general it had been found that in those sections where wheat could no longer be profitably grown fertilizers failed to restore good crops, and it was considered a great point to tell farmers that they must handle barn-yard manure. Conditions in Minnesota were different from those in the East. In plat experiments on land that had been in wheat from 10 to 20 years commercial fertilizers containing the three elements spoken of, with the addition of lime, plaster, etc., were generally found unprofitable. Plats were arranged in long strips, the Minnesota method of seeding wheat being employed,

sometimes with a fertilizer attachment. With crops planted in hills some work had been done with alternate rows; for instance, the pruning of roots in alternate rows.

On motion adjourned to 8:30 p. m.

Evening Session, Wednesday, November 12, 1890.

The joint committee reassembled at 8:30 p. m., Mr. Dabney in the chair.

Mr. Dabney stated that he and his co-chairman, Mr. Sanborn, were obliged to attend the session of another section. He announced the program for the evening, and appointed Mr. Jenkins to preside at the meeting.

The Chairman (Mr. Jenkins) said that the report of the committee on butter standard was first in order.

Mr. Scovell stated that the committee was a joint committee, composed of three members from the agriculturists and three from the chemists. Some of the committee were absent, and probably the report would not be concurred in by all; it was a report of progress, and the committee would ask that the subject be continued for another year. Some data had been expected from Mr. Jordan, of Maine, who was on the committee, but such data had not arrived.

The report was presented, as follows:

REPORT OF COMMITTEE ON BUTTER STANDARD.

Your committee appointed to investigate the matter in regard to a butter standard met at the outset with considerable difficulty just as to what its duties were. The question arose whether the object was to ascertain the amount of butter fat generally present in marketable butter, and from such data ascertain the minimum or average amount of fat in such butter to be used as a standard, or whether its duties were to suggest a uniform standard for butters to be used in butter tests based upon butter fat. From the drift of the debate which resulted in the appointment of the committee rather than from the wording of the resolution under which the committee was appointed, the majority of the committee concluded that the latter was the object sought, and therefore the data collected bear on this subject. It is unfortunate that in so many butter tests of cows so little chemical work has been done, and especially that so few analyses of the butter of the test have been made.

Finally, your committee do not feel justified from the data at hand in recommending at present a butter standard, but ask leave to make this a report of progress and allow it to continue the investigation.

M. A. Scovell,
E. H. Jenkins,
Committee.

Mr. Scovell said that from the drift of the lively debate had last year the committee had concluded that a butter standard was wanted by which to test reports of dairy cows. The question was as to the true basis which should govern calculations. Should the butter contain 10 or 20 per cent of water, or 80 per cent of fat, or what was the basis to be? When a Jersey cow gave 80 pounds of milk a week there were no data

to show what butter fat that contained. The committee believed that for tests made by or through the stations a certain amount of fat, determined from the butter of Jerseys, Holsteins, or other cows, should be adopted as a standard. Unfortunately but few tests had been made.

Mr. Scovell detailed the results of certain tests, referring to the following table and to others which he placed upon the blackboard.

Results of a test of the cow Dora 26001.

Date.	Yield of milk.				Per cent of butter fat found in milk.			Calculated amount of butter fat in milk produced.			
	Morning.	Noon.	Night.	Total.	Morning.	Noon.	Night.	Morning.	Noon.	Night.	Total.
	lbs.	*lbs.*	*lbs.*	*lbs.*	*per ct.*	*per ct.*	*per ct.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
19	20.8	......	20.2	40.10	5.8	......	5.5	1.189	......	1.11	2.299
20	19.8	......	19.12	39.4	6.2	......	5.6	1.209	......	1.106	2.315
21	19.13	13.2	12.1	45.0	5.3	7.2	5.2	1.038	0.945	0.627	2.610
22	15.4	13.3	12.13	41.4	5.7	7.6	6.4	0.854	1.002	0.820	2.676
23	12.7	14.6	13.12	40.9	4.4	7.2	6.4	0.547	1.537	0.880	2.464
24	15.5	12.9	12.14	40.12	6.3	5.4	5.6	0.957	0.678	0.721	2.356
25	14.9	12.6	7.12	34.11	5.6	6.5	6.8	0.816	0.804	0.527	2.147
Grand total	......	......	......	282.3	......	......	......	......	......	......	16.867

Date.	Amount of buttermilk.	Percentage of fat in buttermilk.	Amount of fat in buttermilk.	Amount of fat less fat in buttermilk.	Calculated amount of butter of 80 per cent fat.	Actual butter found by churning.	Per cent of butter fat in butter.	Amount of butter fat in butter.	Loss (−) or gain (+) unaccounted for.	Amount of cream.
	lbs.	*per ct.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*per ct.*	*lbs.*	*lbs.*	*lbs.*
19	7.8	0.2	0.015	2.284	2.13¾	2.13¼	82.21	2.308	+.024	11.4
20	8.0	0.25	0.02	2.295	2.14	2.12½	80.9	2.250	−.045	11.5
21	10.0	0.3	0.03	2.580	3.3½	3.3¾	81.2	2.626	+.046	13.8
22	10.8	0.3	0.032	2.644	3.5	3.81	78.21	2.761	+.117	14.2
23	9.0	0.2	0.018	2.446	3.2	3.4½	80.3	2.634	+.188	12.4
24	8.0	0.2	0.016	2.346	2.15	2.15	82.0	2.406	+.060	11.3
25	7.4	0.25	0.018	2.129	2.11	2.11½	81.1	2.200	+.071	10.12
Grand total	61.0	......	.149	16.724	21.0¼	21.5	......	17.185	+.461	84.6

Mr. Scovell thought it apparent from the reports cited that a continuation of the same standard and calculation of 80 per cent butter fat would afford a fair basis for future experiments. If all cows were alike the amount of butter fat to be produced could be very nearly ascertained by analysis of the milk and skim-milk. It was reported that some cows gave over 1 per cent in skim-milk, however treated. The committee asked to be continued, desiring further time for investigation before recommending the adoption of a regular standard for butter.

It was moved that the report of the committee be accepted and the committee continued.

Mr. Armsby asked whether Mr. Scovell could explain the fact that in many of the reported cases the butter contained more fat than was announced in the milk.

Mr. Scovell said that the amount was in excess in almost every instance; he could not account for it. The butter was analyzed in duplicate and the results were controlled by Babcock's method of gravimetric calculations.

Mr. Hays suggested that in continuing the work the committee should use some cows which had been taken to the State fair, taking "up and down" results for comparison.

Mr. Curtis inquired whether in the analysis of butter fat in the butter the figures "82" meant simply 82 per cent of the commercial butter.

Mr. Scovell said that they did; it was not water-free substance. Slices were taken from the pounds as made, placed in a bottle, slowly melted, and the sample taken.

Replying to a question by Mr. Wing, Mr. Scovell said that he had not meant to state that he could not find a trace of fat in the skim-milk; instead of "trace" he should have said a measurable quantity.

Mr. Wing said he had done some work in creaming milk during the past summer, and some dealers in dairy implements had claimed that the separation of cream according to their methods gave no trace of fat in skim-milk. This he did not believe, analyses by gravimetric methods showing an average of 0.23 per cent.

Mr. Scovell said that by the Babcock method there were little globules of fat, but four together showed less than 0.02 per cent. He could read to half of a division. By the Adams method he got less than the filter paper called for; it was the poorest looking skim-milk he had ever seen.

Mr. Lyons asked Mr. Wing at what temperature he set the milk.

Mr. Wing said that it was set at 44°, sometimes for 12 and sometimes for 24 hours.

Mr. Failyer inquired whether Mr. Scovell had made determinations as to the effect of more or less working upon the per cent of butter fat; whether the amount of water would vary much.

Mr. Scovell replied that the butter had been worked until he gave the order to stop, except in one instance, and in that there was only 78.21 per cent butter fat. Then the salt came to the outside; it did not in any other instance. He was therefore unable to answer the question.

Mr. Failyer said that in some butter a greater per cent of water was indicated, and he had thought it probable that this was because the butter had not been sufficiently worked.

Mr. Scovell said that he had taken the sample as soon as it was weighed.

Mr. Hays said that in working butter practically, without the check of an analysis, he had experienced trouble in getting it uniform as to the amount of water contained. The trouble arose from the time and temperature at which the churn was stopped and the temperature of the wash bottle; if stopped when the globules were small and the water cold, the water could not be worked out so well. He once worked out about an ounce of water to a pound on the scales after another man had worked the butter until he thought he had it dry.

Mr. Myers said that he believed the variation in the butter to be due to variation in churning. He had carried on some work with reference to testing cows by the churn, the agricultural papers having said a great deal about tests of cows, and a good many people, especially Jersey people, having insisted on the churn test. The question was, What reliance might be placed upon the churn test? He was extremely surprised at the closeness with which Mr. Scovell had been able to work in the instances cited. Last winter a long series of tests had been made in West Virginia. Ten pounds of milk were used in each test. It was found that although in the several tests the same quantity of milk was put into the churn and given the same number of revolutions at the same temperature, and all other conditions being made as nearly the same as possible, yet in 10 pounds of milk there would be a considerable variation, amounting to a number of ounces in the yield of cows. It was only necessary to overchurn the milk, or if that was not enough, to let the milk sour a trifle to excess, and throw in an excess of warm or hot water. It therefore appeared that in testing cows practically by the churn there were comparatively untouched problems. He was glad that Mr. Scovell had taken hold of the matter. The question of testing milk was now, he thought, reduced to a mechanical operation. Either Babcock's or Beimling's process would give results within the limits of chemical error, and with either apparatus or by Patrick's or some other method, milk could be tested rapidly in the creamery, so that he hoped the problem might be solved before the next convention of the Association. Light could already be seen, but it might be depended upon that the problem was not to be solved by the churn, which was not the key to the situation. A standard butter would have to be established, and he thought Mr. Scovell was close to the mark in fixing the standard at about 80 per cent. However, the percentage could be made to fluctuate. Eighty-two per cent butter could be raised to 85 per cent in ten minutes by simply working out a little more water, or it could be reduced down to nearly 70 per cent with perfectly fair churning, by stopping the churn, and salting and packing it in, as was done by creamery men. A great many people salted their butter in the churn with brine and sent it off between 70 and 80 per cent butter, keeping the water in on purpose. A practical creamery man who looked at the process used at the station, said that if it were employed in the creameries their business would be broken up by the oleomargarine people; it was necessary to put in more water. On being told that the butter would not then be honest, he replied, "It is all right, it is butter," and that he was willing to buy up all the butter he could, put it in the buttermilk, and give it a most tremendous dashing; he could make a profit by handling the butter in that way. Farmers and creamery men were as tricky as others, and could so doctor their butter as to make a very good quality into a very bad one. The churn was a very poor means of testing butter.

Mr. Scovell said that he had tried to keep the conditions uniform. He had expected to find that the churn was not fit; he thought there would be a great many more variations than there were. The cream was taken from the creamery and put in a stone water bath at 80° F.; he put it in at noon and took it out the next day to churn it; at 10 a. m. it was put in cold water and allowed to remain until it got to 63°. He had not experienced a great variation in churning. At one time when he stopped churning the buttermilk was at a temperature of 62° and at another time it was 66°; it varied so much and no more. He kept the temperature regulated as nearly as possible in churning.

Mr. Curtis said that at his station considerable work in that line had been done, and he was somewhat familiar with the bulletins on the subject. He was surprised at the closeness of Mr. Scovell's results; he would go further and say that he doubted whether they could be duplicated.

Mr. Scovell said that very likely they could not.

Mr. Curtis said that he feared there might be error in the closeness of Mr. Scovell's results. He himself had since his childhood been a practical dairy worker in prime dairies and creameries in different latitudes, and believed that he could churn as well as anybody. He could take test cows from any part of the world, churn their milk before those present, challenging them to detect anything wrong, and would give them the churn and the cows too if he failed to make a difference of from 2 to 10 ounces in their yield. It was utterly impossible for any churner in the United States to churn a dozen samples and work them to the same or within 5 per cent of the same amount of water. He had, therefore, for the last 3 or 4 years emphatically protested, privately and officially, against the use of churns in these tests. The time was rapidly approaching when all public tests would be made by a fat-extracting standard, he did not care by what method, but the simpler the better; it need not be one which a ten-thousand dollar chemist would be required to operate; one which could be worked by a man at 50 cents a day would be better. For the last 2 years he had made tests at the Texas State Fair, using the Patrick test, which had given universal satisfaction to the contestants. He did not believe in 80 per cent butter. If a sample of that, together with a sample of 75 or 78 per cent butter, were submitted for choice to a butter judge—a commission man, not a chemist—he would prefer the lower per cent butter for its flavor.

Mr. Patrick said that the public were rapidly adopting the opinion expressed by Mr. Curtis, being educated up to it by the State fairs, at which in each succeeding year fewer tests were made by the churn and more by the new, quick methods.

The Chairman said that it was questionable whether the ideal dairy tests of the future were to be made at State fairs rather than at the home stables, where the cows are under normal conditions and not worried by the presence of numerous spectators.

Mr. Hays thought that the Association might arrange to have some cows tested just before going to the State fairs and again just after their return, in order to ascertain whether or not the tests made at the fairs were valuable.

Mr. Atwater believed that the question before the meeting was worthy of serious attention. At the State fair in Vermont last year considerable effort was made to compare the milk of a number of cows brought together from all parts of the State. Being considerably interested in the result, he afterwards made inquiry of Mr. Cooke in regard to it, and was informed that it was not at all successful, and the conclusion had been reached that the test made at the fair was not a fair test of the cows. Some time ago the Office of Experiment Stations had received from Vienna copies of a report on such a test made at the International Agricultural Exhibition at Vienna, with the suggestion that the same be sent around to the stations. In replying he had not stated the fact, which he would state now, that the copies were not so distributed because it did not seem that reports of such a test were worth having. While it might be that this was a slightly exaggerated idea, he thought that it contained a good deal of force.

Mr. Neale said that the chemist of the Delaware Station had busied himself since January with analyses of butter made by the separator process, using the old-fashioned churn and the new-fashioned extractor. The lowest percentage of butter fat, according to the speaker's recollection, was 79, and the highest 85; in the vast majority of cases it ranged from 80 to 81, corresponding closely with the results reported by Mr. Scovell.

Mr. Scovell thought it would be well for the Association to adopt 80 per cent provisionally as a standard of comparison in its own work for the year, the data obtained to be reported to the committee, which would save refiguring in case any other basis was finally agreed upon. It was necessary to have a comparison between results by the churn and by analysis. He would recommend as a provisional standard 80 per cent on the test of the milk minus the skim-milk fat.

Mr. Myers said that the matter was now in the hands of the committee, which could send in communications and take such steps as were needful to perfect the investigation.

The Chairman said that Mr. Scovell's last suggestion would be considered as the first communication from the committee.

Mr. Patrick's remarks on a standard milk test were now in order:

A Standard Milk Test, G. E. Patrick.

Mr. Patrick said that the two subjects assigned him (a "Standard milk test," and "Methods for the analysis of milk") were very properly merged into one. The subject of milk tests had already been discussed to some extent, and as that was the more practical branch of the double-headed problem he would treat of it first as distinguished from methods of analysis. By a milk test was meant something different from the method used by the chemist in his laboratory; something was meant which

an unskilled person could employ without a laboratory. All present were familiar with the fact that Europe had furnished us some years ago, with a number of so-called tests, for instance, the lactoscope and lacto-butyrometer, in which a separation of the fat was obtained by shaking up in a tube with ether; also with the lactocrite and with another centrifugal machine, in which the milk was placed in tubes with acid. American chemists had soon ascertained that the first two of these four tests were incorrect; the lacto-butyrometer was superior to the lactoscope, but was found to be not really trustworthy. The other two tests were too costly for general use on this side of the Atlantic, or in fact anywhere. Within the last 3 years, however, there had been a great revival of interest in America as to quick methods of milk testing. First, 2½ or 3 years ago, came Professor Short's, a most excellent method, familiar to nearly all, its outline being merely the saponifying of the fat in the milk by means of an alkali, solidifying the soap and throwing up the fat; and then followed a little bunch—Failyer's, Parsons's, Cochran's, and the Iowa Station test, with which latter the speaker had something to do. These appeared in quick succession about a year and a half ago. It might be said generally that in the first three ether or gasoline was used to dissolve the fat after its separation by means of chemicals, and the ether or gasoline had to be evaporated so as to leave the pure fat. With the exception of the European centrifugal machines the Iowa Station test was the first in which the casein was dissolved and the butter fat left pure without the use of a solvent. Since the shower of milk tests just mentioned nothing notable in their line had attracted much attention until about 3 months ago, when the Babcock and Beimling tests appeared prominently on the dairyman's horizon. The Babcock test had already been mentioned; it required nothing but the mixture of oil of vitriol, sulphuric acid, and milk in bottles brought up to necks, a number of which bottles were placed in a circular frame, their necks turned inward and inclined upward, and the frame made to revolve some 600 or 800 times a minute for 6 or 7 minutes, when the machine was stopped, some hot water put in to carry the fat up into the necks, and the revolution resumed for 2 minutes longer to throw all the butter up into the necks, which completed the test. The Beimling test was not so well known among chemists and dairymen as were some of the others. He had to-day seen for the first time a copy of a recent bulletin from the Vermont Station (No. 21), in which Professor Cooke described its latest form. The simplicity and quickness of that method seemed to place it in advance of any other test. According to the bulletin, one revolution of from one half minute to one minute—say 1 minute—was sufficient to separate the fat and bring it up into the necks of the tubes. He saw the test worked at the Dairy Convention a few days ago, when the time claimed was 2 minutes, but 1 or 2 minutes was sufficient to complete the test after the bottles were filled with the mixture. The question naturally arose, How was it that Beimling's centrifugal test worked quicker than Babcock's? It was simply because those who had perfected the invention of Beimling had introduced new chemicals. Beimling used pure oil of vitriol, and the test now called for oil of vitriol and for a mixture of hydrochloric acid and fusel oil—amyl alcohol—which, according to some tests made by the speaker, seemed to aid in the solution of the casein and also in the raising of the fat to the surface, having a sort of double action.

In regard to a standard milk test, the only one recognized was the gravimetric method, which was not called a test. He did not know that he was prepared to say which of the two or three tests which had been mentioned should be regarded as the standard test, but he would say that for creameries or dairymen who wished to make numerous tests Beimling's was a little nearer the standard than any other because of simpilcity. He supposed that under the head of milk testing would naturally come its application in the work; the chemists were understood to be intimately connected with the dairymen and creameries. It might therefore be of interest to state what the creamery men in Iowa were doing. The test that emanated from the Iowa Station was originally intended for farmers and dairymen, and was put out in such a form

as to aid that class, but it very soon became evident that the only men who cared about a milk test were the creamery men. Undoubtedly farmers, breeders, and private dairymen would come to recognize the importance of testing individual cows and weeding out their herds, but at present it was a lamentable fact that only one in a great many hundreds of them saw the value of a quick-acting method of milk testing. A considerable number of creamery men in Iowa had adopted the plan of buying milk on what was termed the "relative value plan," which was found to work well. It might naturally be surmised that this plan would cause great disgust among patrons, but such was not the case, most of them actually approving the method. Occasionally a man's milk ran low, and he either dropped out disgusted and went into a pooling creamery or stayed where he was, like a man, and tried to grade up his cows as milk producers. The man who dropped out and went into the pooling creamery was not a godsend to its owner, and the patronage of a number of such men could bring about but one financial result. In one instance a relative-value-plan creamery and a pooling creamery were established in the same town, and it took but a few months to wind up the business of the latter; all the patrons with scrub cows went to it and the game was a losing one from the start.

Mr. Myers said that the Beimling test had been used at his station for some time, and to his mind it was by all odds the best test that had appeared, its work being as quick and accurate as could be desired. He was engaged in the preparation of a bulletin upon it when Mr. Cooke's came out. One of the station assistants, who was skillful in handling machinery, undertook with a 6-tube machine of that construction to beat the speaker, who used a Babcock, and succeeded in doing so, completing his tests in less than 2 minutes, starting with the milk in the vessel. These tests, compared with parallel work carried on by gravimetric analysis, using the Adams method, were perfectly correct. The only necessary condition was that the machine be turned long enough; if properly digested every bit of the fat would be thrown up into the tubes. No one engaged in milk investigations could do better than to get one of these machines as soon as possible it would save a great deal of trouble. He had a 6-bottle machine and the operation took only about 2 minutes. The milk was measured out, the hydrochloric acid and fusel oil put in, passing around the six tubes, then the sulphuric acid could be poured in, and while hot the milk was put in. At his station the machine was revolved a little longer than 1 minute; it was turned until it was sure that the butter fat was all out; 2 minutes would do the work completely every time. It worked excellently on separated milk; he had tried it on that and on buttermilk, sweet milk, and cream, but not on very sour milk, from which correct results could not be obtained.

Mr. Patrick said that he had obtained them.

Mr. Armsby said that according to Mr. Cooke the method was not good for skim-milk unless it contained a per cent of fat.

Mr. Myers said that was so unless the tubes were read with a magnifying glass. The tubes were similar to those in a Babcock machine. He always skimmed within one tenth, below which it was necessary either to put in two or three of the measured quantities and take

aliquot parts of the result, or else read the tube with a magnifier. The tubes he used were half the width of the Babcock tubes. Smaller tubes, with gradations of any desired fineness, could be used. In his opinion this machine settled the question of testing milk as to cost, accuracy, and rapidity.

Mr. Curtis said that Mr. Adriance, assistant chemist at his station, had taken the liberty of attempting an improvement on the Patrick tubes. He had a set of half a dozen made to order, a little more than double length, and accurately calculated for the volume used by Mr. Patrick—10.4 c. c. This worked admirably, with the exception that it cooled so quickly that in a large series of tests it was practically impossible to read at a right temperature. It was true that the variation made was not very great, but at the same time if laid in hot water and taken out the fat would begin to get weight in a very few minutes. He himself had, by actual reading, made a difference of more than one tenth, and the time required was so short that he thought the narrow tubes were rather impracticable.

Mr. Patrick asked whether Mr. Curtis meant that there was only one tenth difference.

Mr. Curtis replied he meant that; he had said more than one tenth.

Mr. Patrick said that was not much.

Mr. Curtis said that it made a difference when the tests were multiplied.

Mr. Woll said that the test could be completed by the Babcock method in 2 minutes, provided the machine was revolved at least 800 times a minute, but he thought that point was not of great importance; those who had conducted large series of tests knew that the sampling and addition of acids were the time-taking factors in the operation. In the Beimling test there were two additions, first, that of the hydrochloric acid and fusel oil, and then that of the sulphuric acid; and when a large number of samples were tested there was necessarily a great waste of time. He was therefore inclined to think that the Patrick method, against which he had been prejudiced, was really preferable to Beimling's.

Mr. Failyer asked whether the time was reduced to 2 minutes by variation in the treatment.

Mr. Woll replied that it was a matter of better apparatus. He would say that when the speed was low the results were unsatisfactory; the matter of speed was important.

Mr. Myers asked how Mr. Woll got rid of the nasty curly precipitate that came up and got under the fat in nine out of ten cases.

Mr. Woll replied that excess of heat applied in Patrick's method caused the casein to rise in the fat. His own practice was to whirl for from 2 to 4 minutes, then fill up with hot water, whirl again, and heat the water in the drum so that it was about boiling by the time he was through with the whirling.

Mr. Scovell said that in regard to the quantity in tests of skim-milk, etc., Babcock had suggested that tubes holding four or five times as much milk could be used. The tube would not then have to be narrowed. If necessary 50 c. c. skim-milk could be put in.

Mr. Neale said that in certain lines of work it was absolutely necessary to be cautious in regard to the hundredths of a per cent in skim-milk, which would make a great difference in working on 3,000 pounds of milk, as they did at the Delaware Station.

Mr. Myers said that he had prepared and would publish a table, calculated to the third decimal place, for use in running the Beimling machine; it would enable one to figure as closely as in the ordinary gravimetric method. The Babcock test had disappointed him; the curd rose in the tube, and could not be gotten out without a great deal of trouble. There was something defective in the description or in the manipulation of that test, and whoever tried to carry it out according to Babcock's description would encounter a difficulty not easily overcome.

Mr. Woll said that the difficulty referred to might be entirely avoided by using no heat until after the tubes had been filled up.

The Chairman said that he had had but little experience with the quick methods, but was charmed with their rapidity and accuracy so far as he had tested them. They would certainly fill an important place in practical dairy work. In using them, however, it should not be forgotten that until much more experience was had and data obtained and compiled confirming their accuracy for strictly scientific work, investigators should not permit themselves to be led away from the gravimetric method, which had already been thoroughly tested and must remain as the standard for the present. Everyone who made extremely careful data owed it to himself and to the Association to publish them; until that had been done, these methods should not be trusted in a strictly scientific investigation. He had seen figures of the Beimling machine, but not the machine itself. In using any centrifugal machine, it should be remembered that good chemists were scarce, and if the machine was operated without a protection between the whirling bottles and the eyes of the manipulator it would be well to have a laboratory sweep or a bad chemist work the crank.

Mr. Holter said that at his station, in using Short's method, they had, as noted in their last bulletin, reduced the heat of the solutions one half, and thereby had done away to a very great extent with the mixture of fat and casein. His experience in hundreds of determinations had been that by heating the solutions at the lower temperature he was materially aided in reading the fat found.

On motion, it was decided that the agricultural and chemical committees should meet separately at 8:30 o'clock on the following morning for the transaction of special business, another joint session to be held immediately thereafter.

On motion, at 10 p. m. the meeting adjourned.

THE PERMANENT COMMITTEE ON BOTANY.

Mr. Arthur, of Purdue University, presented the first paper, namely, "Reference books, how to obtain and use them." In the preparation of a bulletin one of the leading things is to present the matter fully and clearly. Many things thought to be new are really old, and this indicates the importance of looking up the literature of the subject. The citations may be given in small type foot-notes with no inconvenience to the general reader and at the same time add greatly to the value of the bulletin to other investigators along kindred lines. There is no doubt that such copious foot-notes carry weight with what is presented above even to the most ignorant reader. In looking up the literature, first examine all general treatises. These often give helpful foot-notes. This is especially true of all the German writings. Among these the following are most important in botanical matters: *Botanischer Jahresbericht*, and *Botanisches Centralblatt.* The agricultural papers are of very little use, but the proceedings of agricultural and horticultural societies often contain much that is good. Sometimes monographs, theses, etc., may be found. The best way to obtain reference books is through second-hand catalogues, mostly in German. Book houses in this and other countries will supply their catalogues upon application. It is not easy to borrow the needed books. It was suggested that the books of all station and agricultural college libraries be listed and each station worker furnished with these lists.

Several took part in the discussion.

The second paper was by Mr. Atkinson on "Anthracnose of the cotton." The fungus, a new *Colletotrichum*, recently named by Miss Southworth, of the U. S. Department of Agriculture, was first observed by Mr. Atkinson upon the leaf scars of the stem. Pure cultures were obtained in agar-agar and peptone broth. Many inoculations were made, the most susceptible parts being the cotyledons of the cotton seedlings.

The idea of a standard nutrient solution for parasitic fungi was suggested, and also that cotyledons may generally be the best parts of a plant for inoculation.

A second paper, on "Black rot of cotton," by the same author was presented at the opening of the session on Thursday morning. This consists of a number of fungi, the dark color being partially due to a *Macrosporium* and *Alternaria*, following usually upon spots infested

with a *Cercospora* and sometimes the *Colletotrichum* mentioned in the previous paper. The "black rust" works upon all soils and in most situations. There is a "red rust" in North Carolina that seems to be due to peculiarities of soil, as thus far no fungus can be assigned as the cause. Sketches and blackboard drawings were shown of both the destructive fungi above treated.

Mr. Thaxter, of the Connecticut State Station, presented the results of his study on the nature and form of potato scab. He found a fungus associated with this trouble which he was able to grow in drop and solid culture. When growing upon agar-agar it has a lichenoid appearance and consists of minute grayish filaments. Many successful inoculations of healthy potatoes were shown and the cause of one form of potato scab is determined. As yet, the place the fungus holds in the classification of its group has not been located. Many inoculations upon agar-agar and healthy potatoes were shown and the methods involved described.

The paper, "New fungous diseases," by L. H. Pammel, was a list, with notes, of the various fungi injurious to crops in central Iowa during the present season. Special mention was made of the wheat blight, plum scab, clover smut, and currant anthracnose. A white mold (*Cystopus*) was found upon the cultivated beet, which is a matter of much interest to both gardeners and mycologists.

During the discussion of this paper, Assistant Secretary Willits visited the section to give an outline of the work in botany as being prosecuted by the Department of Agriculture. He spoke of the importance of botanical work in the station, as it underlies all experimentation with plants. The work should not be merely the collecting of plants, but data as to soil, climate, etc., as related to fungous diseases and crops. The work must be scientific but with a keen eye to the practical side.

Chairman Tracy, of Mississippi, assured the Secretary that there was the closest sympathy between the botanists of the country and the U. S. Department of Agriculture, and that botanical work had received a great impetus during the past few years.

Mr. Fairchild, of Washington, D. C., next presented a paper upon fungicides. An historical sketch of fungicide experiments was given, followed by a grouping of the various substances that have been employed—fifty materials in all. The theory of fungicidal action was pointed out and the importance of a thin soluble film of the compound being spread upon the foliage or affected parts. The substance used needs to be effective, easily spread, and cheap. Figures were given to show the harmlessness of fungicides to man. There are many new compounds recommended this year; several were exhibited and will be tested next year.

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with a *Cercospora* and sometimes the *Colletotrichum* mentioned in the previous paper. The "black rust" works upon all soils and in most situations. There is a "red rust" in North Carolina that seems to be due to peculiarities of soil, as thus far no fungus can be assigned as the cause. Sketches and blackboard drawings were shown of both the destructive fungi above treated.

Mr. Thaxter, of the Connecticut State Station, presented the results of his study on the nature and form of potato scab. He found a fungus associated with this trouble which he was able to grow in drop and solid culture. When growing upon agar-agar it has a lichenoid appearance and consists of minute grayish filaments. Many successful inoculations of healthy potatoes were shown and the cause of one form of potato scab is determined. As yet, the place the fungus holds in the classification of its group has not been located. Many inoculations upon agar-agar and healthy potatoes were shown and the methods involved described.

The paper, "New fungous diseases," by L. H. Pammel, was a list, with notes, of the various fungi injurious to crops in central Iowa during the present season. Special mention was made of the wheat blight, plum scab, clover smut, and currant anthracnose. A white mold (*Cystopus*) was found upon the cultivated beet, which is a matter of much interest to both gardeners and mycologists.

During the discussion of this paper, Assistant Secretary Willits visited the section to give an outline of the work in botany as being prosecuted by the Department of Agriculture. He spoke of the importance of botanical work in the station, as it underlies all experimentation with plants. The work should not be merely the collecting of plants, but data as to soil, climate, etc., as related to fungous diseases and crops. The work must be scientific but with a keen eye to the practical side.

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of the experimental grass and forage station of the U. S. Department of Agriculture at Garden City, Kansas. This station is in a typical region, where the rain-fall is about 20 inches and the native grasses scanty, principally gramma and buffalo grass. In 1888 plats of sods of several kinds of local grasses were transplanted to ground plowed 1 foot deep. In 1889 large areas were sown with seeds of many varieties of grasses and other forage plants. Several acres were also devoted to a variety of sorghums, some of which flourished. Seeds of the most promising native grasses were collected and those of foreign countries imported, and during the present season the work has been prosecuted on an enlarged scale.

Many of the seeds were poor and the unusually dry season has been against the best results. This discouragement has been compensated for in part by the experiments in other directions. Thus 40 acres sowed to winter rye yielded 17 bushels per acre and in an average season would easily have reached 25 bushels. Eighty acres were sown to sorghum of different varieties, all of which grew well until the desiccating winds of June came and ruined nearly all of them.

The experiments warrant the following conclusions: Broad-leaved perennial grasses will not answer, but if the rain-fall is up to the average, the annual broad-leaved sorts, as sorghums, will succeed. Strong, deep-rooting grasses are best, and those with bulbous swellings at the base will endure droughts. Grasses producing large amounts of foliage near the ground, serving as a mulch, are able to survive.

The grasses for cultivation in arid soils are to be sought for in dry countries. Among the species to be considered as very helpful are *Panicum virgatum*, *P. bulbosum*, *Setaria caudata*, *Phalaris intermedia*, *Andropogon scoparius*, several species of *Bouteloua*, *Sporobolus airoides*, and *S. wryhtii.*

Mr. Halsted presented a paper upon "The station bulletin," advocating that it be made attractive in press work and engravings, and that the matter, fully and clearly stated, be within the comprehension of the average farmer. Also, that the scientific journals receive all matters not suitable for the farmers' bulletin but of value to the scientific world.

The following were elected officers for the ensuing year: chairman, Byron D. Halsted, of New Jersey; secretary, Roland Thaxter, of Connecticut.

THE PERMANENT COMMITTEE ON CHEMISTRY.

At the session of the committee on chemistry, Mr. Armsby read the following paper on recent work abroad on the digestibility of feeding stuffs, which opened a discussion of the whole subject:

DIGESTION EXPERIMENTS—RECENT WORK ABROAD, H. P. ARMSBY.

In assigning this topic for discussion, I do not suppose the chairman of the chemical committee desired me to make a categorical statement of all recent digestion experiments and their results, like a section out of the *Jahresbericht* or *Centralblatt.* Such a method of presentation could hardly fail to be superfluous so far as the chemical committee is concerned, and decidedly uninteresting to the other members of the convention.

In place of this, I ask your attention to a brief consideration of some of the tendencies of recent investigation. By a digestion experiment is commonly understood an experiment in which the food of the animal and the solid excreta are weighed and analyzed for a period of several days, and the percentage digestibility of the several ingredients of the food computed from the difference between the amounts eaten and excreted. The seeming simplicity of this method led to its general adoption, and in years past large numbers of such experiments have been made in Europe, especially in Germany. A compilation by Wolff, in Mentzel and v. Lengerke's Kalender for 1888, contains the results of over 1,000 such experiments. A more critical study of the method, however, has led to the recognition of many sources of error. For our present purpose it is not necessary to enter into a detailed consideration of these, but I may mention:

(1) Irregularity in excretion, rendering it uncertain whether the observed amount of excretion corresponds with the amount of food eaten.

(2) The presence in the dung of substances not derived from the food, but coming from the wear and tear of the digestive apparatus itself.

(3) The complications frequently introduced by the incomplete and irregular consumption of food by the animals experimented on.

(4) In the case of concentrated feeding stuffs, the complication introduced by the necessity of feeding along with it some coarse fodder.

Such considerations as these, together with the very considerable amount of trouble and expense connected with a digestion experiment, naturally gave rise to a desire for a simpler and more exact method. Consequently, when Stutzer, in 1880, proposed to apply the methods of artificial digestion outside the body, already in use by the physiologists, to determine the digestibility of the protein of feeding stuffs, his experiments attracted much attention and led numerous other investigators to follow up the subject.

In looking up the literature of digestion for the last 3 years, I made a list of seventeen papers, nine of which were either a study of the methods of artificial digestion or recorded the results of experiments made by this method. Another line of work, which, although not strictly belonging under the head of digestion experiments, yet is of much value and interest in this connection, is that followed by Ellenberger

and Hofmeister, in Dresden. These investigators have made very elaborate studies of the composition of the various digestive fluids of domestic herbivora and of their action on the various nutrients; but more especially they have studied the process of digestion as it takes place under normal conditions in different parts of the alimentary canal. In other words, they have occupied themselves with a physiological study of the *processes* of digestion, while a so-called digestion experiment aims to determine the final quantitative result of these processes. Out of the seventeen papers mentioned above, four related to experiments of this general character. Of the remaining four papers, two concerned themselves with the proportion of metabolic products in the fæces, and only two were digestion experiments as ordinarily understood; that is, determinations of the percentage digestibility of food materials. It is evident from this brief summary that in recent years European investigators have devoted their attention very largely to the methodology of the subject, particularly as related to artificial digestion on the one hand, and on the other, to a study of digestion as a physiological process.

The first branch of the subject is of most immediate interest to agricultural chemists. In order to get a clear understanding of the bearing of recent experiments, it will be desirable to review briefly the earlier results.

Stutzer's first experiments * were made by digesting the finely ground fodder at about the temperature of the body with a dilute solution of pepsin and HCl, followed in some cases by digestion with an alkaline pancreas extract. The general result which he reached was that a certain proportion of the nitrogenous compounds in each case was insoluble in these re-agents. By means of his well-known copper-hydrate method he was able to determine the non-albuminoid compounds, and thus to separate the nitrogenous constituents of the fodders into three classes, namely, non-albuminoids, albuminoids soluble in pepsin-HCl, and albuminoids insoluble in pepsin-HCl.

The latter group he regarded as indigestible by the animal and as probably consisting largely of nucleins, while the pepsin-soluble nitrogen he considered to represent the maximum amount of available protein in the fodder. The next step, naturally, was a comparison of natural and artificial digestion. In every case it was found that artificial digestion gave higher results than natural digestion, or, to express the same thing in another way, the total nitrogen excreted in the dung was more than the pepsin-insoluble nitrogen of the fodder.

Kellner found† a difference between the two of about 0.4 grams of nitrogen per 100 grams of dry matter digested. This difference corresponds to the average amount of nitrogen in the form of metabolic products which he found to be present in the dung in other experiments, and he consequently ascribes the low results of natural as compared with artificial digestion to the disregard of the presence of these products.

Pfeiffer ‡ found a similar difference between natural and artificial digestion. He, however, determined the pepsin-insoluble nitrogen in the dung, and found it to be from 20 to 30 per cent less than the amount present in the fodder, showing that a portion of the latter had been digested by the animal.

Stutzer § found in later experiments, that a treatment of the residue from the pepsin-HCl digestion with alkaline pancreas extract, in some cases, notably with fodders similar to those used by Pfeiffer, extracted from 20 to 30 per cent of the nitrogen which the pepsin-HCl failed to remove. According to him, the pepsin-soluble nitrogen of the dung is not derived from the food, but from the products of metabolism.

By means of experiments on pigs with a fodder containing either no nitrogen or no indigestible nitrogen, Pfeiffer || obtained a dung containing only metabolic nitrogen

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* Jour. f. Landw., XXVIII, 195 and 435; XXIX, 473.

† Centralblt. f. agr. Chem., IX, 763.

‡ Jour. f. Landw., XXXI, 221.

§ Centralblt. f. agr. Chem., XIV, 322.

|| Jour. f. Landw., XXXIII, 149, and Zeitsch. f. phys. Chem., X, 561.

and found the latter to be wholly soluble in pepsin-HCl without subsequent action of pancreas extract, thus confirming to a certain extent Stutzer's view, that the pepsin-soluble nitrogen of the dung comes from this source. In subsequent experiments with sheep upon the digestibility of dried diffusion residues from the sugar-beets, Pfeiffer * found that the pepsin-insoluble nitrogen of the dung corresponded very closely with the pepsin-pancreas-insoluble nitrogen of the fodder, and that by introducing this correction the figures for natural and artificial digestion agreed quite closely with each other, while the results upon the two animals were also rendered more concordant.

Before proceeding to a statement of results of recent investigations on this subject, an exact statement of the questions which must be answered before a final judgment upon the value of the method can be formed, will conduce to clearness. These questions are:

(1) Is the pepsin-pancreas-insoluble nitrogen of a fodder capable of exact determination? That is to say, is Stutzer's method of artificial digestion a conventional one, like the methods for crude fiber or reverted phosphoric acid, in which every change of condition gives a different result, or do fodders contain a group of nitrogenous substances insoluble in these reagents under conditions approximating those of natural digestion?

(2) Does the pepsin-pancreas-insoluble nitrogen of fodders also escape digestion in the animal and reappear in the dung?

(3) Does the pepsin-pancreas-soluble nitrogen of the dung belong exclusively to the so-called metabolic products?

An affirmative answer to these three questions would establish the accuracy of Stutzer's method, but in my judgment no final answer is now possible to any one of them. I shall consider recent results in their bearings on these three questions rather than discuss separately those obtained by each experimenter.

First, then, is the pepsin-pancreas-insoluble nitrogen of fodders capable of exact determination? Stutzer claims that the successive digestion with pepsin-HCl and alkaline pancreas extract, as prescribed by him, gives the maximum of possible digestible nitrogen. This is indicated in his earlier experiments on the action of pepsin-HCl alone, when increase of the volume of digestive fluid, of the time of digestion, and of the strength of acid used, gave but very insignificant increase in the digestive action beyond a certain point. In a recent paper † he has compared the action of a pepsin solution containing 0.2 per cent of HCl with that of a less volume of one in which the proportion of HCl was gradually increased to 1 per cent in the course of the experiment. Three different fodders were used in these experiments. It was found that when the action was continued for 10 hours only, the more acid solution dissolved the larger amount of nitrogen, but that subsequent digestion of the residue with pancreas solution diminished this difference, or in some cases caused it to disappear entirely. When the digestion with pepsin-HCl was continued for 24 hours and followed by the action of pancreas solution the results were identical whether the stronger or the weaker solution was used. What is specially worthy of note in this connection is that an increase of the time of digestion from 10 to 48 hours did not increase the amount of nitrogen dissolved.

Niebling ‡ has compared the action of equal volumes of the two solutions just mentioned (that is, pepsin with 0.2 per cent HCl and the same with 1 per cent HCl) upon two fodders, and found the less-acid solution slightly less efficient, both by itself and when followed by digestion with pancreas extract, although the latter reduced the differences. Treatment of the fodder with 1 per cent HCl alone and then with pancreas extract also dissolved more nitrogen than was removed by the 2 per cent pepsin-HCl-solution followed by pancreas extract. These results, however, are only

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* Jour. f. Landw., XXXIV, 444. † Landw. Vers. St., XXXVI, 321.
‡ Landw. Jahrb., XIX, 149.

apparently in conflict with Stutzer's. They show that with less acid in the solution than is prescribed by Stutzer slightly less nitrogen is dissolved, but they do not show whether, by increasing the strength or volume of the solution or the time of action, beyond the limits prescribed by Stutzer, still more nitrogen would be dissolved.

The indications, then, seem to be in favor of an affirmative answer to the question under discussion, but the results are far too few to suffice for any decisive conclusions. It would seem that further experiments upon this point might very profitably and easily be made; especially would it seem desirable to try the effect of successive treatment of the same substance with the digestive fluids. A comparison also of commercial scale pepsin, which has generally been used in this country, with the pepsin solution prepared directly from the stomach of the pig, according to Stutzer, would be desirable.

Our second question was, Does the pepsin-pancreas-insoluble nitrogen of the fodder escape digestion in the animal? As was noted above, Pfeiffer found that the pepsin-HCl-insoluble nitrogen of the dung corresponded quite closely to the pepsin-pancreas-insoluble of the fodder. Niebling, in his recent paper, found that the pepsin-pancreas-insoluble nitrogen of the dung was but slightly less in amount than that of the fodder. Jordan,* on the other hand (to trespass for a moment on ground assigned to the next speaker), found the pepsin-HCl-insoluble nitrogen of the dung on the average less in amount than the pepsin-pancreas-insoluble of the fodder, though this was not true in all cases. If we assume that in Jordan's experiments further digestion of the dung with pancreas solution would have dissolved more nitrogen from it, as was the case in Niebling's experiments, it would appear that some of the pepsin-pancreas-insoluble nitrogen of the fodder was digested by the animals, and the same remark may be made as regards Pfeiffer's experiments, just mentioned.

As regards our second question, then, the results are somewhat conflicting, and it is plain that further investigation upon this point would also be desirable, and would cost but comparatively little trouble, as Pfeiffer seems to have shown that all the metabolic nitrogen of the dung can be dissolved by pepsin-HCl.

Our third and most important question is, Does the pepsin-pancreas-soluble nitrogen of the dung belong wholly to the metabolic products contained in it? Pfeiffer's results upon dung containing only metabolic products, while they show that these are soluble in pepsin-HCl, do not show that in normal dung this re-agent does not also dissolve other material, and consequently the agreement of the results of artificial digestion with those of natural digestion corrected by his method is not conclusive evidence upon the point in question.

In Niebling's experiments, it was found that after all this metabolic nitrogen had been removed from the dung by pepsin-HCl there was a further quantity which was removed by digestion with pancreas extract. It would seem that this quantity must have been derived from undigested residues of the food, since, as previously stated, the pepsin-pancreas-insoluble nitrogen of the dung was practically equal to that of fodder. Extraction of the dung with ether, alcohol, and hot water to remove bile products, and with cold lime-water to remove nuclein, has generally extracted less nitrogen than digestion with pepsin-HCl. If we assume that this treatment is sufficient to remove all metabolic nitrogen, then the excess removed by pepsin-HCl must come from the food, but it appears to be at least doubtful whether this assumption is justified. Indeed, the difficulty connected with investigation of this branch of the subject lies in the absence of any criteria by which we can judge whether any given method removes from the dung all the metabolic nitrogen and no nitrogen from any other source. A study of this branch of the subject, while involving many difficulties, is unquestionably the direction which investigation must take in order to remove a very serious source of inaccuracy from our present methods—either natural or artificial—of determining digestibility.

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* Maine Station Annual Report, 1888, p. 196.

As an appendix to the above may be noticed results of an investigation by Weiske* into the nature of the pepsin-HCl insoluble nitrogenous compounds of the dung. Stutzer, it will be remembered, considered them analogous to nuclein. Liebermann has shown that when nuclein from yeast is extracted with cold dilute nitric acid the extract contains metaphosphoric acid, while the residue has all the properties of ordinary albuminoids. Weiske submitted sheep dung to this treatment and obtained phosphoric acid, but the nitrogenous compounds of the residue were no more soluble in pepsin-HCl than before, from which fact he concludes that they were not nucleins. He also observed that simple treatment of the dung with nitric acid extracted as much nitrogen as treatment with pepsin-HCl, and concluded that the HCl is the active agent in the latter case.

A brief notice of investigations by Hofmeister† upon the nitrogenous constituents of the contents of the alimentary canal, states that he found great variation in the amount of metabolic products in different parts of the digestive apparatus, but insufficient details for discussion are given in the abstract, and I have not had access to the original paper.

Some results recently obtained by the use of the method of artificial digestion may also be briefly noted. Morgen‡ has applied it to the determination of the digestibility of fresh, dried and ensiled diffusion residues from sugar-beets. He finds that the protein of this latter material is not, as has been generally assumed, wholly digestible, but only to the extent of 75 to 80 per cent. Drying at a moderate temperature or ensiling did not decrease the digestibility. Drying at 125° to 130° C., however, did diminish the digestibility considerably.

Siebert§ finds that the addition of 0.5 to 2 per cent of salt does not diminish the digestibility of protein as determined by Stutzer's method.

Cohn|| finds that a pepsin-HCl solution tends to prevent the acetic and lactic fermentations, and that the gastric juice thus has a preservative action on the contents, of the stomach.

Stutzer¶ finds that Fahlberg's saccharin interferes with digestion by pepsin-HCl but questions whether his results are of general applicability.

In addition to his work on the artificial digestion of protein, Stutzer** in conjunction with Isbert has endeavored to devise a method for the artificial digestion of the carbohydrates of fodders by the action of ptyaline or diastase. The authors start with the assumption that the crude fiber of fodders is without nutritive value. By the successive action of disastase, pepsin-HCl, and pancreas extract they seek to determine the digestibility of the total organic matter, the carbohydrates, and the protein. The hasty conclusion to which not a few rushed, after the publication of Tappeiner's results upon the fermentation of cellulose in the digestive apparatus of herbivora, that this substance is of no value in nutrition, soon gave place to more moderate views; and Pfeiffer, in a critique on Stutzer and Isbert's results, has no difficulty in showing that the method, or rather the conclusions deduced from it, leads to absurd results in case of fodders containing much crude fiber. As a method for determining the digestibility of the nitrogen-free extract of fodders, however, it has had no adequate test, so far as I am aware, and for this purpose it seems worthy of some attention.

The second class of investigations mentioned at the outset of this paper, namely, those relating to the *process* of digestion, are of less direct agricultural interest, and this paper is already so long that it may be dismissed with a few words.

The general plan of these experiments, so far as they relate to the process of digestion in the normal animal, has been to slaughter animals at different intervals of time after a ration of known quality has been eaten, and examine separately the

* Jour. f. Landw., XXXVI, 459.
† Centralblt. f. agr. Chem., XVII, 317.
‡ Jour. f. Landw., XXXVI, 309.
§ Centralblt. f. agr. Chem., XVII, 315.
|| Centralblt. f. agr. Chem., XVIII, 730.
¶ Landw. Vers. St., XXXVIII, 63.
** Centralblt. f. agr. Chem., XVII, 112.

contents of different portions of the alimentary canal. It has thus been shown that the digestive process is more complicated than has frequently been represented and that different chemical or fermentative actions may go on even in different parts of the same organ. In the stomach of the horse and hog, for example, it was found that in the cardiac end amylotic action may be taking place while in the pyloric end proteolytic digestion is going on. One important practical result from these experiments has been to show the importance of the saliva as a digestive fluid. It has generally been taught that when food enters the stomach the acid gastric juice immediately suspends the action of the saliva. These investigations have shown that in herbivora with a single stomach the action of the saliva upon the food may continue for 2 or 3 hours in the stomach. This fact is suggestive when taken in connection with the favorable results which have been obtained by Henry from the use of dry food as compared with wet.

In this hasty survey of the field assigned me I have sought to indicate the general character and tendencies of recent work rather than to report all its details.

In Europe a large amount of statistical work upon the digestibility of different fodders has been already completed. With us much remains to be done in this direction. We stand very much where the European investigators stood 30 years ago as regards our knowledge of the digestibility of our feeding stuffs, but with this important difference, that we have the benefit of their experience and investigations as to the experimental methods to be employed.

Our stations might profitably do much more work than they are now doing in determining the digestibility of American feeding stuffs, but it will be a great misfortune if in doing this they blindly follow the traditional methods and fail to devote a proper amount of attention to the questions which, as I have pointed out, are now occupying the minds of experimenters across the ocean.

Mr. Frear, of Pennsylvania, contributed the results of some investigations of the metabolic products in dung and of the action of pepsin solution on dung. In the discussion following attention was called to the fact that in artificial digestion with an acid pepsin solution as usually carried out, sufficient hydrochloric acid was added to seriously interfere with or wholly suspend the proteolytic action of pepsin. Hydrochloric acid of itself, of course, has a proteolytic action, but an addition of 0.5 per cent or even 0.3 per cent hydrochloric acid may suspend the action of pepsin.

Mr. Woll gave a brief account of observations made at the Wisconsin Station on the size and number of fat globules in cows' milk. The method followed was devised by Dr. Babcock, and consists essentially in diluting the milk with 49 volumes of water, taking the mixture in capillary tubes under the microscope, counting the globules between the divisions of an eye-piece micrometer, and from the diameter of the capillary calculating the volume of the milk in which the globules were counted.

The number was found to be from 100 to 400 in $\frac{1}{10000}$ cubic millimeter. In the course of lactation the number of globules increases, but the size decreases. Thus the number of globules per unit of volume may be quadrupled during lactation while the size will diminish in much the same proportion. In animals of different breeds, as pure-blooded Jerseys and Holsteins, the period of lactation has a greater influence than the breed on the size of the globules. The food also has

a marked effect, dry food as a rule increasing their size and wet food having the contrary effect.

Mr. Jenkins, of Connecticut, read a paper on newly proposed apparatus, methods, etc., also a paper, by Messrs. Johnson and Osborne, of Connecticut, on the determination of phosphoric acid in phosphates containing oxide of iron and alumina. The authors show that while the official method is perfectly reliable for ordinary superphosphates and bones, it can not be used for the analysis of phosphates containing considerable quantities of the oxides named. For such phosphates the original Sonnenschein method must be employed.

In the discussion of apparatus and methods the Excelsior Mill was strongly recommended for grinding coarse fodders—hay, straw, cornstalks, etc. Its action, however, is rather cutting than grinding, and for reducing seeds, such as maize kernel, Mr. Neale called attention to a mill made by Drewes, of Halle, Germany, from plans furnished by Dr. Maercker, which consists essentially of a steel mortar and pestle driven by machinery; the pestle slowly revolves in one direction and the mortar in the other. For reducing sorghum and similar things, which are apt to be very sticky and clog the mill, he had found very useful a meat-chopping machine, with a revolving block and cutting knife some 10 inches long, which delivers 200 blows a minute.

After further discussion the committee nominated to the Association Mr. A. T. Neale as chairman of the permanent committee on chemistry for the next year, and Mr. C. D. Woods as secretary. The committee then adjourned.

THE STANDING COMMITTEE ON COLLEGE WORK.

The committee held several sessions at which the principal subject of discussion was the Morrill act. At an early meeting a subcommittee was appointed to draw up resolutions formulating the conclusions of the committee in regard to this act.

At a meeting held Thursday morning, November 13, this committee, through its chairman, Mr. Alvord, reported as follows:

The section on college work having had under consideration the obligation of the colleges under the act of Congress approved August 30, 1890, and the limitations thereof, recommend the adoption of the following declarations by this Association:

(1) That every college should keep a separate and distinct account with the income provided directly from the Treasury of the United States, and that charges against the same should be in the order of importance and preference: (*a*) for instruction in agriculture and mechanic arts; (*b*) for facilities for such instruction; (*c*) for instruction in the other branches of learning specified by the law; (*d*) for facilities for this latter class of instruction.

(2) That an effort be made to soon obtain the opinion of the Secretary of the Interior as to what class of expenditures will be approved by his Department under the clauses providing for "facilities for instructions," and that until official decision upon this point is promulgated college officers should confine expenditures under this head to such things as directly aid instructors in preparing their work and imparting knowledge to their pupils.

(3) That in view of the history of the new Morrill act, and the decision of the First Comptroller of the Treasury, under it two annual payments are now due and payable to the States; and the fact that instruction during the academic year of 1889-90 is a thing of the past, the annual payment of $15,000 for the year ending June 30, 1890, should be held and regarded as an equipment fund, and reasonable time allowed for its deliberate expenditure; and that the annual payment now part due for the year ending June 30, 1891, should be applied to the expenses of the current academic year.

(4) That the officers of this Association be requested to respectfully urge upon the Secretary of the Interior the early payment to every State and Territory having one or more institutions organized under the act of July 2, 1862, of both payments now due under the supplementary act of 1890, in accordance with the evident intention of Congress to apply these benefits equally to all States, and in order to avoid impeding the progress and development of industrial education, which would result from withholding payments, and reporting the same to Congress. It is believed that this would simply cause unnecessary delay, and certainly result in an enabling act or joint resolution sustaining the views thus expressed.

(5) That the first reports to the Secretary of the Interior by college presidents and treasurers should be made in the year 1891, before the 1st day of September, and should cover the operations of the year ending June 30, 1891, and the disbursements of the income for that year, as well as such expenditures as shall have been then made from the first payment of $15,000.

(6) That the interests of education will be conserved by making the Bureau of Education the depository of all papers and reports, and the agency for preparing all business between the Department of the Interior and the States and colleges under the act of August 30, 1890; and that the debate in the Senate of the United States June 21 and 23, 1890, indicates the intention of Congress as to the agency by which the duties of the Secretary of the Interior were to be performed under said act.

(7) That the college officers should endeavor to bring to the attention of the legislatures of their respective States at the earliest possible date the necessary legislative action under the provisions of the new Morrill act, and that until such action is perfected the representatives of the colleges present at this convention pledge their action and influence to insure an equitable division or impartial application of all moneys received under this act in full accord with the spirit of the law.

Mr. PEABODY. I move the report be received and taken up by paragraphs for discussion. The motion was carried.

The first paragraph of the report as amended and adopted was as follows:

That every college should keep a separate and distinct account with the income to be derived under the act of Congress approved August 30, 1890.

Mr. SCOTT. I move the second paragraph be laid on the table.

Mr. ALVORD. I would like to inquire of the gentleman making the motion whether it is his intention thereby to prevent the expression of opinion as to the expenditure of the money.

Mr. SCOTT. I prefer to let the law speak for itself and each college decide for itself.

Mr. INGERSOLL. I understand there is nothing binding in this report; that it simply recommends.

Mr. SMART. I do not agree with that view in reference to the proper division of this money. I think there is great danger in having it said that you have gone to Congress and got money to raise salaries and get more men. People are very sensitive about increasing salaries and getting additional men. While it was stated that we needed instruction, it was distinctly stated and ably urged that we especially needed greater facilities; that other schools largely endowed were standing in the lead because they had greater facilities, and that we needed facilities for instruction. Those who were present will remember that at the first meeting of the Senate Committee, at which representatives of the colleges were present, a suggestion was made that there was danger in taking this money, because the people would say, What is it for? It was granted for facilities for instruction, but it has been used for something else. You have increased your salary list unnecessarily, or you have paid an unnecessary amount to your station. That may not happen, but I believe there is great danger in expending this money for salaries. I think the section ought to make some declaration which

would indicate that we intend to carry out this law in its spirit. I move that this paragraph be postponed until later in the meeting.

Mr. HADLEY. If I understand Mr. Smart, I agree with him exactly I am in favor of the motion to postpone.

The second paragraph of the report was laid on the table, and the third paragraph was then read.

Mr. FAIRCHILD, of Kansas. My object in moving to postpone the consideration of this paragraph is not to curtail in any respect the discussion, but it seems to me that we are trying to interpret the law too closely.

Mr. TURNER. I do not believe it is possible to make any satisfactory statement upon this subject, because the words which include also exclude, and it is very difficult to draw the line in exactly the right place. I think in this matter, as in every other matter of practical administration, we should use our good common sense, and determine on its own merits the question whether a particular facility for instruction properly comes within this law.

Mr. ALVORD. I entirely agree with Mr. Turner. It is a great deal safer to act upon our judgment in the expenditure of this money, and according to our several and varied needs, than to run too often to the Secretary of the Interior for a decision. With my board of trustees I have to take responsibilities which are sometimes quite burdensome. I do what in my judgment is best, and then I take the matter before my board of trustees, having acted under the discretion vested in me, and the board of trustees approves or disapproves it.

Mr. SCOTT. I move that this section be referred back to the committee, with instructions to draft a resolution which shall simply advise the institutions to be discreet about the expenditure of this fund.

The motion to recommit was carried.

Mr. SCOTT. I move that the second section, postponed a moment ago, be taken up and recommitted to the committee with the same instructions.

The motion was adopted, and the fourth paragraph was read.

After considerable discussion this section was amended and adopted. The other sections of the report were taken up in order and disposed of after discussion. The report was then referred back to the committee for final revision.

The resolutions as reported back from the subcommittee and finally adopted read as follows:

DECLARATIONS AS TO THE NEW MORRILL ACT.

The section on college work having had under consideration the obligations of the colleges under the act of Congress approved August 30, 1890, and the limitations thereof, recommend the adoption of the following declarations by this Association:

(1) That every college should keep a separate and distinct account with the income to be derived under the act of Congress approved August 30, 1890,

(2) That in the expenditure of the new college income the institutions here represented should conform to a strict interpretation of the language of the law as to the application of these funds.

(3) That in view of the history of the new Morrill act and the decision of the First Comptroller of the Treasury, under it two annual payments are now due and payable to the States, and the fact that instructions during the academic year of 1889–90 is a thing of the past, the annual payment of $15,000 for the year ending June 30, 1890, should be regarded as far as practicable as an equipment fund, and that the annual payment now past due for the year ending June 30, 1891, should be applied to the expense of the current academic year.

(4) That the officers of this Association be requested to respectfully urge upon the Secretary of the Interior the early payment to every State and Territory having one or more institutions organized under the act of July 2, 1862, of both payments now due under the supplementary act of 1890, in accordance with the evident intention of Congress to apply these benefits equally to all States and Territories, and in order to avoid impeding the progress and development of industrial education which would result from withholding payments and reporting the same to Congress.

(5) That the first reports to the Secretary of the Interior by college presidents and treasurers should be made in the year 1891 before the 1st day of September, and should cover the operations of the year ending June 30, 1891, and the disbursements of the income for that year, together with the use of the first payment of $15,000.

(6) That this Association desires to acknowledge its approval of the courtesy and liberal spirit shown by the Secretary of the Interior to the new Morrill act, and is gratified by the assignment of the business arising under this act to the Bureau of Education with which the institutions concerned have official relations already cited, and it is respectfully suggested that the future transactions between the Secretary of the Interior and the colleges may be simplified and all interests concerned benefited by making the Bureau of Education the depository of all records and reports, and the medium for direct intercourse with the colleges on all matters requiring the final act of the Secretary of the Interior.

(7) That the college officers should endeavor to bring to the attention of the legislatures of the respective States, at the earliest possible date, the necessary legislative action under the provisions of the new Morrill act; and that the representatives of the colleges present at this convention pledge their action and influence to insure an equitable division or impartial application of all moneys received under this act in full accord with the spirit of the law.

The chairman of the committee called up the question, "Should this Association take any action in cases where formal charges of misuse of the United States appropriations are made against any college or station?" appointed for discussion in the general session of the convention, but by vote referred to the committee on college work. The pressure of other matters was so great that the discussion of this question was indefinitely postponed.

Mr. Dabney called attention to United States Senate bill No. 2779, relating to the engineer corps of the Navy and providing for the admission, upon certain terms, of the graduates of the agricultural and mechanical colleges to that corps. He moved that a committee of three be appointed to coöperate with the officers of the Navy Department to promote the passage of a bill known as Senate bill No. 2779, and that the committee draft resolutions to be presented by the committee on college work to the general association for adoption.

After full and careful discussion the motion was amended and adopted as follows:

Resolved, That a committee of three, consisting of the chairman of the committee on college work and Messrs. Smart and Dabney, be appointed to aid in the passage of Senate bill No. 2779, in order by that means to advance the interests of mechanical instruction in the colleges represented in this Association.

In place of his paper called for on the program and entitled "Waste in college work," President Smart made a few remarks on the same subject, and in response to an invitation made by formal motion of the committee, agreed to present his paper in full at the next annual convention.

THE PERMANENT COMMITTEE ON ENTOMOLOGY.

MORNING SESSION, TUESDAY, NOVEMBER 11, 1890.

The committee was called to order at 10:35 a. m., by the chairman, Mr. Forbes.

Mr. Gillette was elected secretary.

The committee proceeded to the reading of papers, the first of which, by Mr. Gillette, entitled "Certain notes and observations of the season at the Iowa Experiment Station,"* comprised the following points: (1) To prevent squirrels from pulling corn; (2) Kerosene emulsion as a sheep dip; (3) The scurvy bark-louse; (4) Experiments with the arsenites; (5) Cut-worm parasites; (6) Insect diseases; (7) Potato-stalk weevil; (8) Pyrethrum experiments; (9) Kerosene extract of pyrethrum as an insecticide.

After discussion, a paper on the "Life history of *Baris confinis*, Lee" (published elsewhere), was read by Mr. Weed.

EVENING SESSION, TUESDAY, NOVEMBER 11, 1890.

Mr. Forbes in the chair.

Mr. Atkinson read a paper on "A new root rot disease of cotton" (published in Insect Life, vol. III, No. 6).

Mr. Weed read a paper on the "Life histories of certain *Aphididæ*." (The substance of this paper is given in the article entitled "Fifth contribution," by Mr. Weed, in Insect Life, vol. III, No. 6.)

On motion of Mr. Weed, the committee extended a cordial invitation to all entomologists present to take an active part in the meeting.

Mr. John Marten read a paper entitled "New notes on the life history of the Hessian fly" (published in Insect Life, vol. III, No. 6).

The committee then adjourned to 10 a. m., November 12.

MORNING SESSION, WEDNESDAY, NOVEMBER 12, 1890.

The committee was called to order by the Chairman, Mr. Forbes.

The minutes of the previous meeting were read and approved.

On motion of Mr. Smith a subcommittee of three was appointed by the Chair to confer with the committee on coöperation with the Association of Official Economic Entomologists, for the purpose of recommending

* Published in Insect Life, vol. III, No. 6.

means of obtaining more time and liberty for meetings of the present committee, and to increase, if possible, its membership in the future. Messrs. Smith, Weed, and Garman were appointed.

Mr. Woodworth read a paper entitled "The laboratory method of experimentation" (published in Insect Life, vol. III, No. 6).

Mr. Beckwith, of Delaware, read a paper entitled, "Practical notes on the use of insecticides" (published in Insect Life, vol. III, No. 6).

Mr. Weed read a paper entitled "Life history of *Pimpla inquisitor*," an abstract of which is published in Insect Life, vol. III, No. 6.

Evening Session, Wednesday, November 12, 1890.

Mr. Forbes in the chair.

The following officers were elected for the ensuing year: chairman, Mr. Cook, of Michigan; secretary, Mr. Gillette.

The subcommittee appointed to confer with the committee on coöperation with the Association of Official Economic Entomologists reported through its chairman, Mr. Smith. The report as adopted was as follows:

The committee on entomology respectfully begs to state to the general association that the papers presented by its members have been found of such general interest to station workers and teachers, and that so much advantage has resulted to individuals, all of which will redound to the benefit of the stations and colleges, that they are encouraged to ask that if possible the programs be so arranged hereafter that more time shall be given to the consideration of special topics by the permanent committees.

Mr. Woodworth moved that one member of the committee be appointed to act conjointly with two other persons, one from the permanent committee on botany and one from the permanent committee on horticulture, to secure if possible a set of standard, uniform connections for nozzles and pipe fixtures used in spraying machinery.

Mr. Alwood was appointed by the Chair to act in this capacity.

On motion of Mr. Cook the committee decided that in the circular sent out to call their next annual meeting a cordial invitation should be extended to any persons not members to be present and take part in the meeting.

Mr. Howard read a paper entitled "The host-relations of parasitic *Hymenoptera*" (published in Insect Life, vol. III, No. 6).

Mr. Snow (University of Kansas) presented a paper (published in Insect Life, vol. III, No. 6), the substance of which was as follows:

Experiments for the Destruction of Chinch-Bugs in the Field by the Artificial Introduction of Contagious Diseases, F. H. Snow.

These experiments have been continued through the two seasons of 1889 and 1890, and have been remarkably successful. As entomologist to the Kansas State board of agriculture I had prepared an article for the annual meeting of that board in

January, 1889, stating what was known at that time upon the subject, and calling attention to the investigations of Professors Forbes, Burrill, and Lugger. In June, 1889, a letter was received from Dr. J. T. Curtiss, of Dwight, Morris County, Kansas, announcing that one of the diseases mentioned in the article (*Entomophthora*) was raging in various fields in that region, and stating that in many places in fields of oats and wheat the ground was fairly white with the dead bugs. Some of these dead bugs were at once obtained and experiments were begun in the entomological laboratory of the university. It was found that living, healthy bugs, when placed in the same jar with the dead bugs from Morris County sickened and died within 10 days. A Lawrence newspaper reporter learning of this fact, published the statement that any farmers who were troubled by chinch-bugs might easily destroy them from their entire farms by sending to me for some diseased bugs. This announcement was published all over the country, and in a few days I received applications from agricultural experiment stations and farmers in nine different States praying for a few "diseased and deceased" bugs with which to inoculate the destroying pests with a fatal disease. Some fifty packages were sent out during the season of 1889, and the results were in the main highly favorable.

It was my belief that sick bugs would prove more serviceable in the dissemination of disease than dead bugs. I accordingly sent out a circular letter with each package, instructing the receiver to place the dead bugs in a jar for 48 hours, with from ten to twenty times as many live bugs from the field. In this way the disease would be communicated to the live bugs in the jar. These sick bugs being deposited in different portions of the field of experiment would communicate the disease more thoroughly while moving about among the healthy bugs by which they would be surrounded. This belief was corroborated by the results. The disease was successfully introduced from my laboratory into the States of Missouri, Nebraska, Indiana, Ohio, and Minnesota, and into various counties in the State of Kansas. A report of my observations and experiments in 1889 has been published in the Transactions of the Kansas Academy of Science, vol. XII, pp. 34–37, also in the Report of the Proceedings of the Annual Meeting of the Kansas State Board of Agriculture in January, 1890.

The next point to be attained was the preservation of the disease through the winter in order that it might be under my control and be available for use in the season of 1890. To accomplish this result, I placed fresh, healthy bugs in the infection jar late in November, 1889, and was pleased to note that they contracted the disease and died in the same way as in the earlier part of the season. I was not able to obtain fresh material for the purpose of testing the vitality of the disease germs in the spring of 1890 until the month of April, and then only a limited supply of live bugs could be secured. I quote the following from my laboratory notes:

April 10, twenty-five chinch-bugs that had hibernated in the field were put in the infection jars. They were supplied with young wheat plants. The bugs appeared lively and healthy.

April 16, some of the bugs were dead and all appeared stupid.

April 20, all of the bugs were dead.

One week later a new supply of fourteen bugs was put into the jar; they were supplied with growing wheat. They ran substantially the same course as the first twenty-five. Some had died at the end of the first week and all were dead by the end of the thirteenth day.

The chinch-bug seemed to have been very generally exterminated in Kansas in 1889, and only three applications for diseased bugs were received in 1890 up to the middle of July. On account of the limited amount of infection material on hand I required each applicant to send me a box of live bugs, which I placed in the infection jars, returning in a few days a portion of the sick bugs to the sender. The three applicants above noted reported the complete success of the experiments. I give the following letter from Mr. M. F. Mattocks, of Wauneta, Chautauqua County, Kansas:

WAUNETA, KANSAS, *July* 7, 1890.

Professor SNOW,

Lawrence, Kansas:

DEAR SIR: I received from you a few days since a box of diseased chinch-bugs. I treated them according to instructions, and I have watched them closely and find that they have conveyed the disease almost all over my farm and the bugs are dying at a rapid rate. I have not found any dead bugs on farms adjoining me. I here inclose you box of healthy bugs that I gathered 1½ miles from my place. I do not think they are diseased.

Yours,

M. F. MATTOCKS.

* * * * * * *

I personally visited Mr. Mattocks' farm and verified the above statements.

The difficulty of obtaining enough live bugs to experiment with in the laboratory led to the sending out of an advertisement, which was forwarded to twenty prominent papers on August 14, with requests for its publication. * * *

This request for live bugs was given wide circulation and resulted in keeping the laboratory fairly well supplied with material for experiment.

Before the close of the season of 1890 it became evident that there were at least three diseases at work in our infection jars, the "white fungus" (*Entomophthora* or *Empusa*), a bacterial disease (*Micrococcus*), and a fungus considered by Dr. Roland Thaxter to be *Isaria* or perhaps more properly *Trichoderma*.

The following report, which describes the bugs as "collecting in clusters," points to the bacterial disease as the cause of destruction in the field:

PIQUA, KANSAS, *July* 12, 1890.

DEAR SIR: Since writing you from Humboldt, Kansas, the 6th instant, I have made the happy discovery that the germs of contagious disease sent me were vital. On Sunday last upon examination of the millet field I found millions of dead bugs. They were collected in clusters. My idea is that dampness facilitates the spread of the contagion. The first distribution of diseased bugs two days after I received the package by mail, apparently produced no results. A part of them were retained in the infection jar (quart Mason fruit jar); one half pint of bugs were collected from the field; 3 days later a foul stench was found to emanate from the jar, and a part of the bugs in it were dead. On July 3, I took advantage of the cool, damp evening and taking a few buckets of cold water sprinkled the edge of the millet and distributed more infected bugs. On the 6th I found millions of dead bugs. I think the night and sprinkling the millet caused the disease to spread—we have had no rain in this neighborhood since June 17, if I remember correctly. The depredations of chinch-bugs are always more serious in dry, hot weather. Have not had my mail since writing you from Humboldt the 5th.

You have conferred a lasting benefit on the farming interests of the United States, the value of which can not be estimated in dollars and cents. It was estimated that during one of the visitation years of this insect the damage in the Mississippi Valley amounted to 10 million dollars. I have no doubt that by a proper manipulation of the contagious disease by intelligent persons it will prove an effective remedy. I think the contagion should be introduced among them early to prevent the migration of the young brood. In my case I received it too late. Early-sown millet presents a favorable place to infect the bugs, as they seem to collect in the shade and die. Hoping that when the next legislature meets an appreciating public will suitably reward you for your beneficent discovery. I am,

Gratefully yours,

J. W. G. MCCORMICK.

The field experiments were apparently equally successful in the months of July, August, and September.

[A field report from J. F. Knoble, of Florence, Kansas, is here given to indicate the favorable light in which the farmers regarded the experiment.]

The following report from R. L. Stangaard is inserted as being of a more scientifically circumstantial character than most of the other reports:

FLORENCE, KANSAS, *August* 22, 1890.

Prof. F. H. SNOW,
Lawrence, Kansas:

DEAR SIR: In reply to your favor of July 27, last month, would say that infected bugs were applied after they were kept with live ones about 42 hours. They were applied as follows:

Most of the bugs mixed were dead when taken out of the box. They were applied in seven different hills, being put into every ninth hill. I marked every hill with a number so as to be better able to watch the progress.

Examined after 48 hours' application with the following results: No. 1, mostly dead; No. 2, bugs mostly alive, seemingly very restless; No. 3, bugs seem to be sick; No. 4, bugs mostly dead (on hills around it the bugs seem restless); No. 5, not examined (on hills around it the bugs seem to be affected, sick). Examination 8 days after application with the following results, to wit: No. 3, bugs seemingly in a dying condition; on the hills around it the bugs seem to be well, with exception of one hill, where they seem to be dying and some dead; No. 4, not a live bug in the hill; No. 5, apparently dying, also dying in the hills around this; No. 6, bugs dying in hill; No. 7, apparently not dying.

On August 16, 12 days after application, I found the bugs to be dying and dead all through the field (12 acres).

On August 20, I again found the bugs to be dying rapidly. A field 40 rods distant had sure marks of bugs in a dying condition. What I mean by bugs in a dying condition is this: Some lay on their backs almost motionless, and others lay in the same position, moving limbs violently.

This remedy was applied on A. G. Rosiere's farm, on Bruno Creek, Marion County, Kansas, being 9 miles east and 3 miles south of Marion.

Thanking you for your favors, I remain,

Yours, truly,

R. L. STANGAARD.

October 16, many of the bugs were dead; the others apparently lively. The dead bugs were found to contain hyphal bodies similar to those with which they were infected. A live chinch-bug from the same jar was crushed and found to contain round hyphal bodies, but these refused to germinate.

November 5, not all of the bugs are yet dead. The few remaining are apparently lively.

The following is a summary of the results of the field experiments in the season of 1890:

Number of boxes of diseased bugs sent out, thirty-eight. Seven of these lots were either not received or received and not used. Reports were received from twenty-six of the thirty-one remaining cases. Of these, twenty-six reports three were unfavorable, nineteen favorable, and four doubtful concerning the success of the experiment. These doubtful cases are not to be looked upon as unfavorable, but more evidence is needed to transfer them to the list of favorable reports. Thus nineteen out of twenty-six reports, or 73 per cent, were decidedly favorable. The experiments will be continued during the season of 1891. In presenting this paper I wish to acknowledge the invaluable aid continually received during the progress of the work from my assistants, Messrs. W. C. Stevens and V. L. Kellogg.

The laboratory experiments have been continued through the season. Of the three diseases identified, that produced by the *Trichoderma* appears to be less fatal than the other two, as is indicated by the following laboratory notes:

September 28, dead chinch-bugs, showing no sign externally of fungus, were taken from the infection jars and crushed on a glass slide in distilled water. Oval hyphal

bodies of a fungus (*Trichoderma*) were found in considerable number. These were put under a bell jar.

September 29, some of the hyphal bodies had put out slender mycelial growths, others, in immense numbers, were multiplying by division.

October 1, the hyphal bodies were still multiplying by division. The mycelial growths had become much longer, and in some instances had variously branched.

October 3, a dead chinch-bug taken from an infected field was crushed on a glass slide in distilled water. Both round and oval hyphal bodies were found in considerable numbers. These were put under a bell jar to prevent drying.

October 4, both round and oval hyphal bodies were multiplying by division and were putting out mycelial growths.

October 5, fresh chinch-bugs from an uninfected field were immersed in the liquid containing the above fungi, and were put in a new jar with young corn plants.

To Mr. Riley's question as to which of the three diseases mentioned was most common in destroying the bugs in the field experiments, Mr. Snow said that during the dry summer of the present year he thought the bacterial disease did most of the work, but in 1889 he thought the fungous diseases were most destructive.

Mr. Riley thought the fact that Mr. Snow had been able to carry healthy bugs through the season without infection in the same room with diseased bugs was rather a discouraging one, as it would indicate either that the germs were easily kept from reaching the bugs or that they were not carried long distances. Close proximity to, or actual contact with diseased individuals, if necessary, would materially lessen the value of their use in the field, while the evidence of farmers' experience in the field needed very careful weighing, because of the possibilities of error.

Mr. Snow said it had been found by his experiments that the diseases would spread over large fields and destroy nearly all the bugs within 10 or 12 days after the diseased bugs had been introduced, and that the expense was very slight.

Mr. Webster stated that it had been his experience that the spread of the *Entomophthora* was entirely dependent upon proper atmospheric conditions, and that he thought the disease might be continued from year to year by massing the bugs on small patches of some favorite food plant or millet where they are to be infected and destroyed and then to grow upon this ground the next year some crop to which the bugs are partial. In this manner the bugs the following year accumulate on the ground where the germs are most abundant, and most favorable natural conditions would be offered for starting the disease when proper atmospheric conditions were present. He did not think actual contact necessary for the communication of the fungous diseases, neither did he think that corn fields present favorable situations for the spread of the infection.

Mr. Snow thought none of the germs would live over winter under ordinary out-door conditions, but only in protected situations, and it was his opinion that such an attempt as Mr. Webster proposed, to carry the germs over from one season to another, would not succeed. His

own experiments had shown that the diseases can be kept alive in the laboratory through the winter and sent out the next season on demand, as explained in his paper.

Mr. Cook stated that foul brood was readily carried over winter in a bee-hive, and he thought it not unlikely that the chinch-bug diseases might be carried over in the same way.

Mr. Fletcher thought that where the disease has been it is liable to appear again when proper conditions are present.

On motion of Mr. Harvey the committee tendered Mr. Snow a vote of thanks for his interesting and valuable paper.

Mr. Smith moved that the paper and discussions of the committee be sent to Insect Life for publication. The motion prevailed.

The committee adjourned.

THE PERMANENT COMMITTEE ON HORTICULTURE.

This committee was represented by ten workers, viz: Alwood of Virginia, Burrill of Illinois, Goff of Wisconsin, Green of Ohio, Lyon of Michigan (representing the Division of Pomology, U. S. Department of Agriculture), McCluer of Illinois, Massey of North Carolina, Taft of Michigan, Troop of Indiana, and Waldron of North Dakota.

Methods of note taking were discussed. The tabular system with blanks for special columns and remarks seemed most satisfactory.

It was agreed that varieties are tested for the benefit of the public and not for the introducers. Variety testing is necessary, but should not end with simply ascertaining what particular variety is earliest, or most productive, or keeps best. The information secured in variety testing should lead to the development of superior varieties at our experiment stations or it does not fulfill its whole mission. Especially should our experiment station horticulturists pursue the most advanced kinds of plant breeding, as, for example, the development of disease-resisting varieties and the securing of crosses with reference to acquiring special qualities now wanting; in other words, the kind of plant breeding that the ordinary seed grower does not undertake.

Mr. McCluer gave an interesting and instructive account of some experiments in crossing corn.

Mr. Waldron mentioned several of the promising wild fruits of North Dakota.

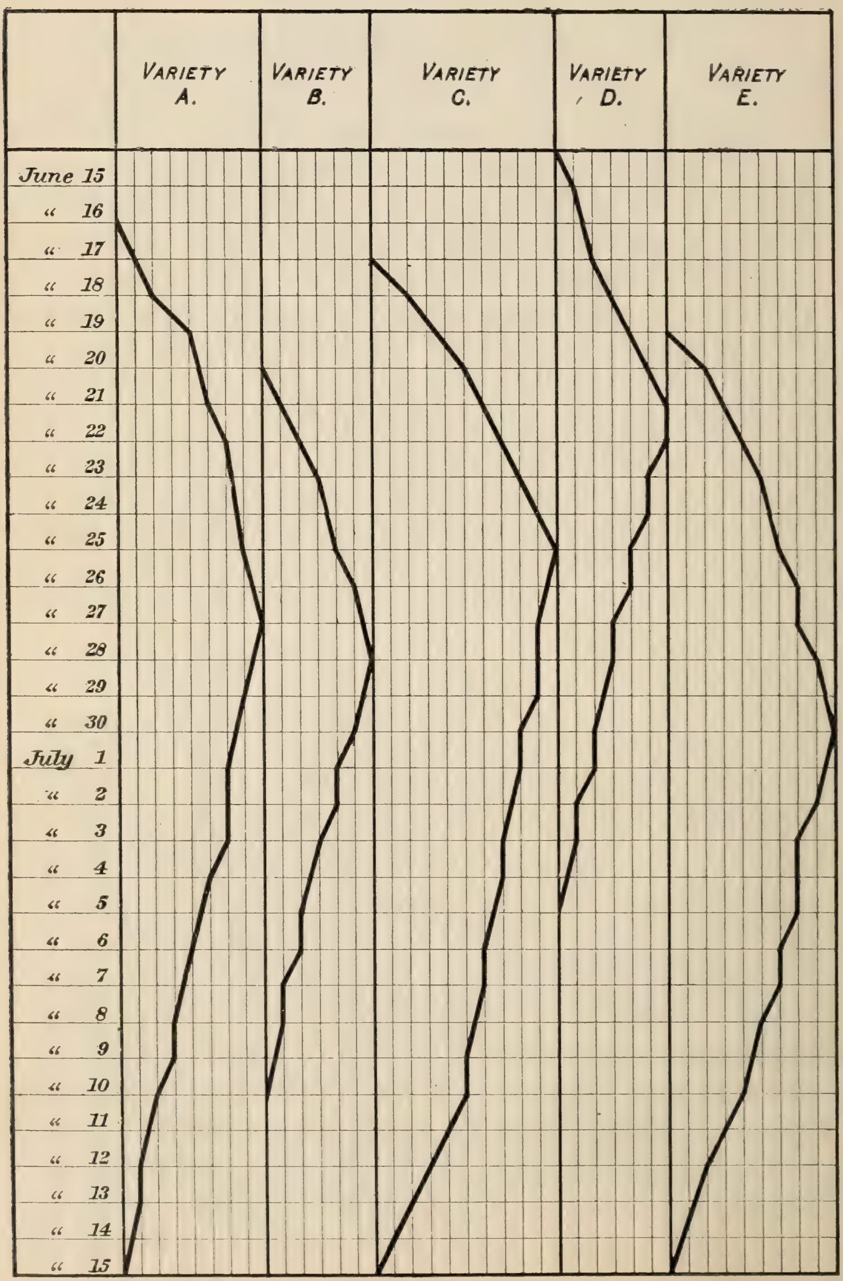
Mr. Goff explained a very concise and clear method of reporting the yields of small fruits and other crops in which the harvesting is necessarily done at frequent intervals. This method is shown in the accompanying illustration: The dates of the various pickings are recorded at the left and the names of the varieties are written at the top of the broad vertical columns. The narrow columns within the broad columns represent units of measurement. The yield of each variety at each picking is counted from the left side of the broad column, each vertical line representing one quart, pound, or bushel, as the case may be. The comparative maximum yield of the different varieties is shown by the width of the broad columns. The relative earliness or lateness appear clearly by glancing across the top or bottom of the diagram, while the length of time the variety continues in bearing appears from the total length of the yield line.

The election of officers resulted in the choice of Mr. E. S. Goff, of Wisconsin, as chairman, and Mr. W. J. Green, of Ohio, as secretary.

Members were urged to prepare and forward papers for the next

meeting, without waiting to ascertain if their presence would be possible.

The report of the committee on reform of vegetable nomenclature was read in the general session by Mr. Goff, and a paper on methods of work in variety testing was read by Mr. Green.



INDEX.

NAME LIST.

SUBJECT LIST.